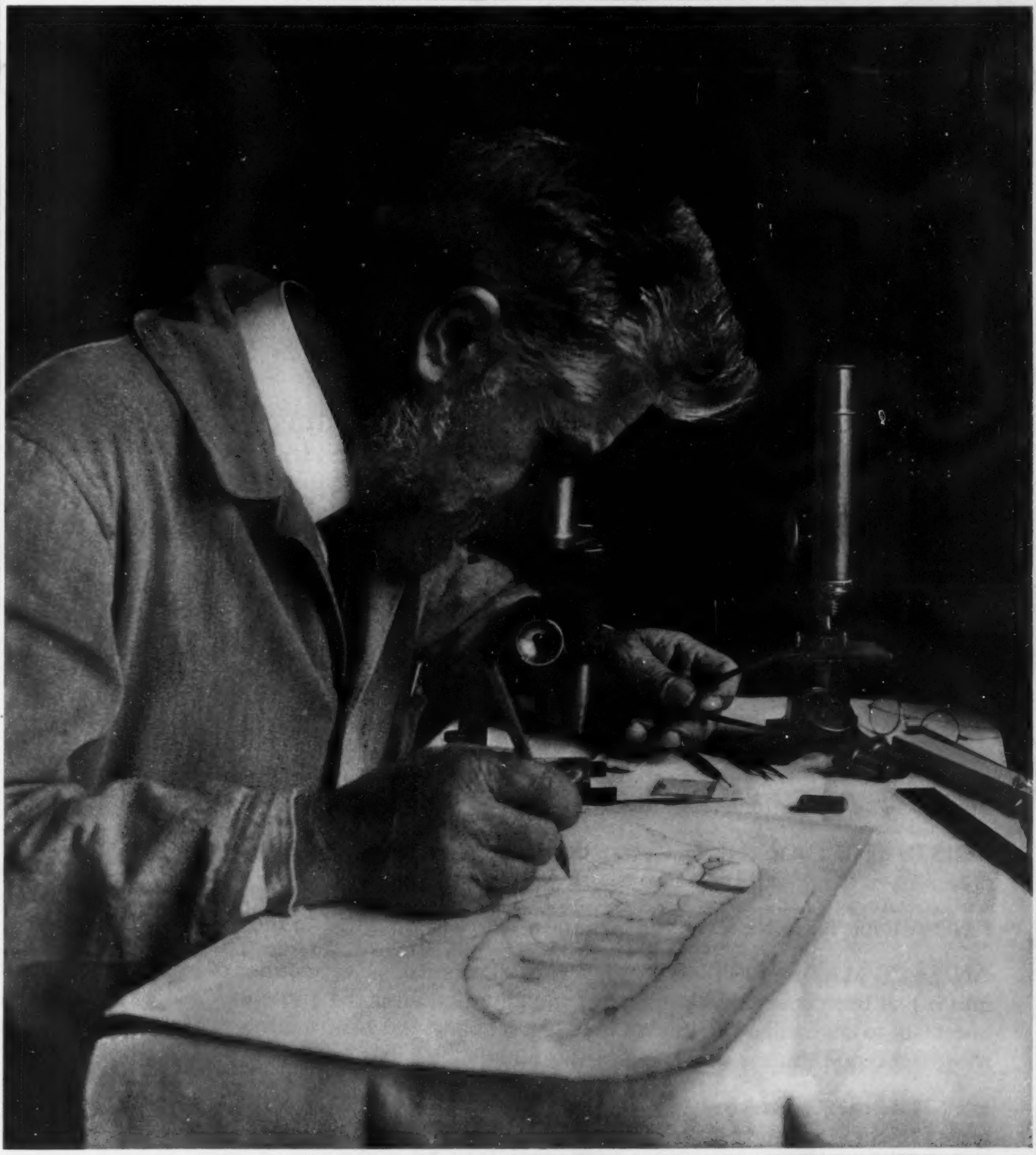
SCIENTIFIC AMERICAN



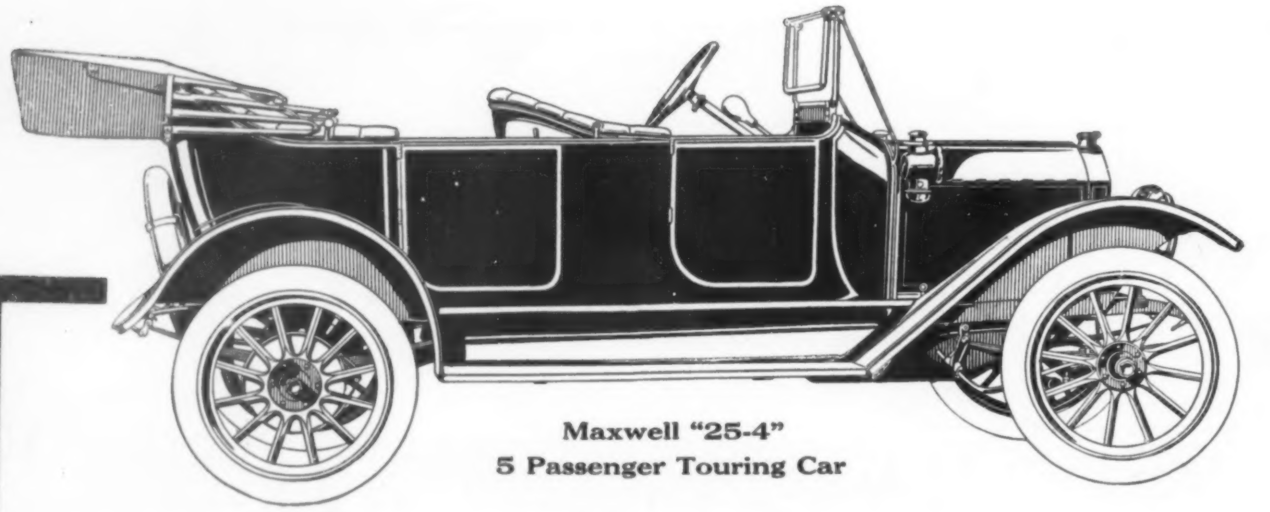
A HUGE MODEL OF THE FLEA

Problem of Our Navy—V. The Battle-Ship Strength Necessary to Guarantee Peace

Vol. CX. No. 13
March 28, 1914

Munn & Co., Inc., Publishers
New York, N. Y.

Price 10 Cents
$3.00 A Year



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SEVENTIETH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CX
NUMBER 13.

NEW YORK, MARCH 28, 1914

PRICE 10 CENTS
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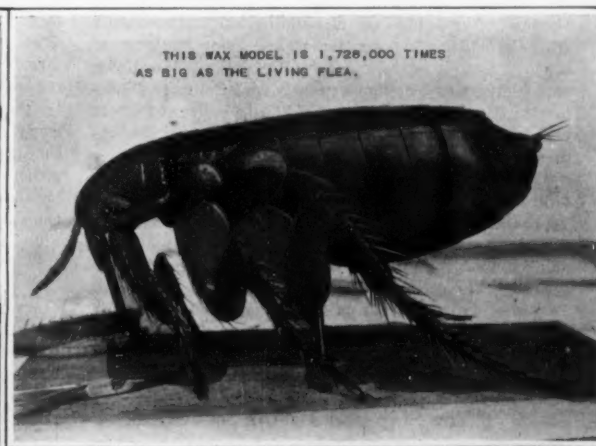
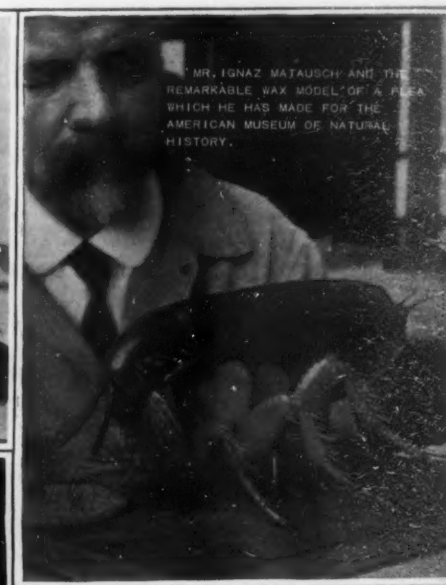
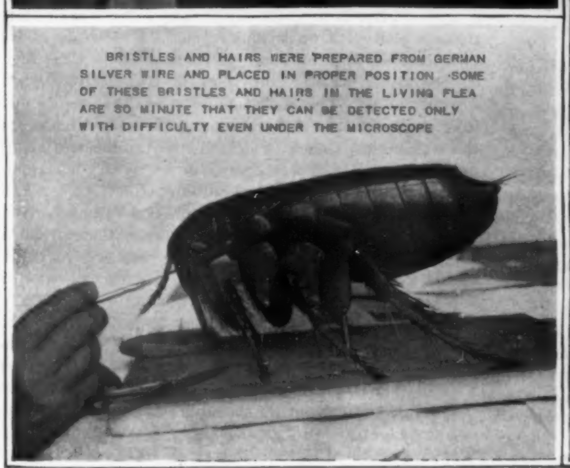
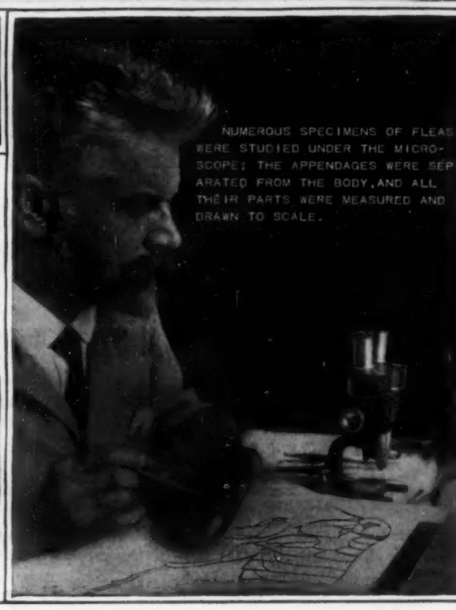
MODELS OF EACH PART WERE PREPARED IN MODELING CLAY AND CAST IN PLASTER OF PARIS AND FROM THESE PLASTER MOULDS HOLLOW MODELS OF THE PARTS WERE MADE IN A WAX COMPOSITION.


THIS WAX MODEL IS 1,728,000 TIMES AS BIG AS THE LIVING FLEA.


MR. IGNAZ MATAUSCH AND THE REMARKABLE WAX MODEL OF A FLEA WHICH HE HAS MADE FOR THE AMERICAN MUSEUM OF NATURAL HISTORY.


BRISTLES AND HAIRS WERE PREPARED FROM GERMAN SILVER WIRE AND PLACED IN PROPER POSITION. SOME OF THESE BRISTLES AND HAIRS IN THE LIVING FLEA ARE SO MINUTE THAT THEY CAN BE DETECTED ONLY WITH DIFFICULTY EVEN UNDER THE MICROSCOPE


NUMEROUS SPECIMENS OF FLEAS WERE STUDIED UNDER THE MICROSCOPE; THE APPENDAGES WERE SEPARATED FROM THE BODY, AND ALL THEIR PARTS WERE MEASURED AND DRAWN TO SCALE.


MORE FORMIDABLE THAN ANY QUADRUPED IS THE FLEA. HE TRANSMITS THE GERMS OF BUBONIC PLAGUE FROM THE RAT TO MAN AND FROM MAN TO MAN.

How the American Museum giant model of a flea was made.

A Huge Model of the Flea

NOT the least striking and instructive of the thousands of exhibits in the American Museum of Natural History are the large models of common insects, which have attracted the wondering attention of thousands. Is the mosquito really so fierce an animal? Is the fly so horrible? Who made these models? How did he do it? Probably every one of the visitors to the American Museum of Natural History who has seen these wonderful models has asked himself these questions. Not one in ten thousand realizes that the models are works of art in their own particular way, and that in the whole world there are probably not more than two or three artists who are sufficiently skilled in entomology, and whose hands are sufficiently trained and dexterous to produce this work. The American Museum of Natural History is fortunate in having secured in Mr. Ignaz Matausch one of these very few and highly exceptional scientific artists to prepare its models. It may be safely said that Mr. Matausch is probably the only man on this side of the Atlantic Ocean capable of executing such work.

Mr. Matausch's latest creation is a flea magnified in wax 1,728,000 times the size of the insect in bulk. In other words, 1,728,000 actual fleas could be packed into his model if it were hollow. Although the model excites admiration because of the skillful manner in which it was prepared, it tells nothing of the painstaking preliminary studies which were necessary before work could be commenced.

Strange as it may seem, no picture has ever been made of the living flea. The insect as it is pictured in text books is a dead insect. To the uninformed it seems a very trivial matter whether a flea is magnified in wax alive or dead. The entomologist knows better. He knows that the segments telescope after death because of the shrinkage of the internal organs.

Accordingly Mr. Matausch began by making an entirely new external anatomical study of the flea. Numerous specimens of the insect were observed under the microscope, so far as possible in the living condition. When all that could be learned had been thus acquired and drawings had been carefully made to scale, the appendages were separated from the body. While even the dissection of the larger members is a test for any skilled hand, what shall be said of bristles and hairs so minute that the point of the finest dissecting needle is enormously larger than the part to be separated? The task is not unlike that of severing a human hair from the scalp with the aid of a crowbar. Literally, dozens of drawings had to be made to scale; each part had to be minutely measured.

After all this painstaking preliminary work models of each part were prepared of the desired size in modeling clay and forms made in plaster of Paris. From these plaster forms hollow models of the parts were made in a properly colored wax composition. The hollows in the wax parts served for the wires in the legs and other supports and connections which give stability to the whole. The finishing of the details of the structure then followed. Bristles and hairs were prepared from German silver wire and placed at the points revealed in the drawings by microscopic study. The whole model was thereupon colored, assembled and treated with a coat of lacquer to preserve it.

Those who look at this flea in the American Museum of Natural History will see far more than even the eye of a trained entomologist sees with the aid of a powerful microscope. So small were some of the hairs (for example, the two that project upward from the mouth parts of the insects) that days of patient observation were required before at last their point of attachment could be seen in a particularly favorable moment.

Perhaps that organ of the enlarged insect which will attract most attention is the biting mechanism. As pointed out by Carroll Fox in a bulletin of the United States Public Health Service on "The Rat and Its Relation to the Public Health," the flea does his biting with a beak which consists of three inner and two outer parts. The middle one of the inner parts terminates in a piercing point; the others in saw-like endings. They are close together and constitute the salivary and sucking ducts, through which the saliva is forced into the wound and blood extracted. The two outer parts form a protecting case at rest and are not inserted, but serve as a guide, doubling back in the act of biting. They probably assist the piercing parts from the wounds. In front of the beak are two plate-like members, ending in a sharp edge; after the piercing parts are inserted deep enough, they help in enlarging the wound.

It is with this beak that the flea sucks up blood. When the bubonic plague infection prevails, it is the bite of the flea that transmits the germs from rat to man, and from man to man.

For Shingles Alone, 750 million feet of timber is cut in that part of the State of Washington which lies west of the Cascades.

50 billion = total cut

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Munn & Co., Inc., 361 Broadway, New York

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately, simply, and interestingly, the world's progress in scientific knowledge and industrial achievement.

The Lesson of a Ferryboat Collision

THE recent collision in the North River between a Lackawanna Railroad ferryboat and a freight-car float, which occurred in broad daylight, draws attention to a danger in ferryboat navigation on this waterway, which only needed such an accident as this to show how disastrous its results may be. We refer to the practice, altogether too common, of navigating two ferryboats which are steaming in the same direction, with the second boat in close proximity to the one ahead. The danger lies in the fact that the leading boat obstructs the view of the pilot of the second boat to such an extent that, when the leading boat changes course, the following boat may suddenly find herself in close proximity to a craft which was shut out from view by the boat ahead. In the accident referred to, the "Ithaca" of the Lackawanna Line left her dock at the foot of Barclay Street at about the same moment as the Erie ferryboat "Goshen" left her berth at the foot of Chambers Street. The "Ithaca" was steaming on the port quarter of the "Goshen," and so close that a biscuit could be tossed from one boat to the other. Then, upon the "Goshen" turning to port and clearing the bow of the "Ithaca," the latter boat found herself only a few hundred feet from a Jersey Central float laden with ten freight cars. There was no room to maneuver, and the float crashed into the ferryboat, crushing and killing three of the people in the cabin. Those who make constant use of the ferryboats in the North and East Rivers will understand from the above how this accident happened; for they will have often noticed that one boat will follow another in such close proximity that its view ahead is very much obscured, particularly as regards the observing of such low-lying craft as a float or tugboat. The danger is so real that we think it would be advisable to pass a law requiring ferryboats to reduce speed, when in close proximity to a boat ahead, sufficiently to enable them to be maneuvered in any sudden emergency that may arise.

Stresses in Railroad Tracks

WE are greatly interested to note that a subcommittee has been appointed by the American Society of Civil Engineers to co-operate with a similar committee of the American Railway Engineering Association to conduct tests on stresses in railroad tracks. A sum of $10,000 has been subscribed by the United States Steel Corporation to pay the expenses of this investigation, and we understand that this sum has been supplemented with $2,000 by the American Society of Civil Engineers. Doubtless, as the importance of this investigation is realized, other contributions will be forthcoming, and a sufficient sum will be available to render this investigation as comprehensive and searching as it must be to secure adequate results.

So far as we know, except for limited experimental work done by individual engineers, there has been no attempt to determine with scientific accuracy the amount and kind of stresses to which modern railroad track, including every element from the grade line through the ballast, ties, and rail, is exposed by the action of moving trains. Considering that the track lies at the foundation of successful railroad transportation, it is surprising that it was not subjected periodically to careful and exhaustive physical tests, to determine the nature and extent of the stresses to which every part of it is subjected under the various conditions which exist both in track and traffic. These things are known, of course, in a general way. It is understood, for instance, that a soft, yielding spot in the subgrade will cause the rail to be subjected to bending stresses far greater than those which occur under normal conditions. We know that the same results will follow if two or three adjoining ties are badly tamped while those beyond them on either side are fully tamped. We know that during the frost of the late winter, the heat of the rays of the sun, especially under certain atmospheric conditions, may soften the roadbed where the sun strikes full upon it, leaving the adjoining stretch of track, which may be under the shadow of a bridge or a building, in a thoroughly frozen condition—a situation which, as in the case of the accident on the New York Central at Woodlawn several years ago, no doubt greatly contributes to derailments. But the engineer would like to know how great and how sudden may be the change in track conditions due to such juxtaposition of sunlight and shadow.

These questions and many others will now be determined by this Committee, which doubtless will take up the subject of tie plates, screw spikes, track spikes, the best form of rail-joint fastenings and many another subject upon which, even at this late hour, much valuable light is needed. The Safety First movement is very much to the front in these days, and we do not know of any contribution to safety which can exceed in importance the work of this committee, the list of whose membership was given in our last issue.

The Ship and Its Lifeboats

THE International Conference on Safety of Life at Sea, whose meetings extended from November 12th, 1913, to January 20th of this year, has published a convention embodying the results of its deliberations, which will be ratified on the last day of this year, and will come into force on July 1st, 1915. We hope to give an early and more extended reference to this convention; but for the present we direct attention to the more important sections, dealing first with the construction of ships and second with the provision of lifeboats. Broadly speaking, it must be admitted that the work of the conference, representing as it does the conscientious and earnest labor of some of the ablest and most experienced minds connected with the construction, control and operation of ships, is certain to exercise a decided influence on the future design and operation of steamships.

The conference dealt through its five sub-committees with the following subjects: Safety of Navigation, Safety of Construction, Wireless Telegraphy, Life-saving Appliances, and Certificates. As was to be expected, the various sub-committees found no difficulty in reaching practically unanimous conclusions on the questions of Safety of Navigation, Wireless Telegraphy, and Certificates. The greatest division of opinion developed in the sub-committee on Safety of Construction and to a less degree in that on Life-saving Appliances; and it is to these two subjects, which to our mind are strictly interdependent, that we confine ourselves in the present discussion.

It developed during the inquiry into the "Titanic" disaster, held under Lord Mersey, that in the years preceding that disaster, the question had been raised and rather fully debated, as to whether the number of lifeboats which a passenger ship was required to carry should not have a certain, definite relation to the degree of safety against sinking which had been secured in the construction of the ship itself. The "Titanic," which failed so completely in the hour of extreme trial, both as regards the unsinkable qualities of the ship itself and as regards the provision of lifeboats, had been built, as was shown at the time, in strict conformity to the requirements of the Board of Trade. The Board of Trade rules demanded that the spacing and height of the bulkheads of the "Titanic" should be such that she could fill two adjoining compartments without sinking below a draft that would bring the water level within a foot or two of her bulkhead deck. They required, also, that she should provide lifeboat accommodation for about one third of those on board. Both of these conditions were fulfilled. The "Titanic," however, was so badly ruptured that at least five of her compartments were opened to the sea—and she went down; furthermore, the boats available carried only about a thousand passengers, and over fifteen hundred of her complement were lost with the ship.

The rules adopted by the London Convention require that the height and spacing of the bulkheads shall be such that three of the largest compartments of a passenger ship of the type of the "Titanic" may be filled without endangering the ship, and there are other provisions as to height of bulkheads and the watertightness of the bulkhead decks, which if ratified and followed, will produce a much safer ship than those built under the existing laws. Whether the sub-committee on construction has gone far enough in the direction of safety is a question open to debate; we are inclined to think that it might have made its rules more stringent without imposing any serious burden of cost upon the shipping companies.

The recommendations of the sub-committee on Life-saving Appliances are so sweeping that we cannot help but feel that the committee was unduly influenced by popular clamor and by the well-meant, but ill-digested opinions of the popular press. This committee calls for the provision of lifeboats for every soul on board; and this, in the case of the largest trans-Atlantic liners, 900 to 950 feet in length, means that their top decks must be lumbered up with a mass of lifeboats so large that in the event of emergency it is improbable that, even under favorable conditions, they could all be safely loaded and got away from a sinking ship.

There is no doubt that this provision was influenced largely by recognition of the fact that, however perfect the sub-division of a big ship may be, there will always be the possibility that a serious fire will necessitate everybody on board taking to the boats. As against this view, it should be noted that the Committee on Construction calls for the provision of fireproof walls, or bulkheads, running across the passenger accommodations at stated intervals, which must be capable of confining a fire to that section in which it originates. If this provision is adequately carried out, we believe that the occurrence of a conflagration that would drive everyone to the boats would be a very remote contingency. To sum up, we consider that it is entirely within the resources and skill of the ship designer and ship builder to produce a ship which shall be at once practically unsinkable and practically fireproof. If this be true, such a ship need carry only a limited number of boats, sufficient, let us say, for the ordinary uses of docking, and for assisting in the transfer of passengers to the rescuing ships which have been called to the vicinity by wireless.

The SCIENTIFIC AMERICAN, from the very day of the "Titanic" catastrophe, has laid down the principle that the proper method of safeguarding the lives of passengers at sea is to make every ship so far unsinkable, that, in the event of serious disaster, it will act as its own lifeboat, and take care of its passengers until they can be either brought into port or transferred at sea to other ships. The mere logic of the thing teaches us that the only safe and thoroughly reliable lifeboat is the ship itself. Can it be denied that the mass of small craft, open boats, motor boats, life rafts and what not, that encumber the top deck of an Atlantic liner are, in a sense, a confession of failure—an admission on the part of the architect and ship owner that although they have succeeded in making the ship big, fast and luxurious, they have not succeeded in making her safe? We note that our contemporary, the *Engineer* of London, is now taking this sensible view of the case. "Boats," it says, "are a continual rebuke to the shipbuilder and the ship commander; for they remind him that his skill is still so far wanting that his vessel is still liable to accident on the high sea. It must be the object of both men to remove that rebuke."

However, the London Conference calls for boats for all. We understand that one of the big 900-foot ships that will make her maiden trip to New York during the coming summer will enter port with no less than ninety-two lifeboats crowded upon its top deck. Well, if it must be so, we can only express the hope that the gradual appreciation of the fact that a big ship can be made practically unsinkable, will lead to the reduction of this unnecessary top hamper, and that ultimately a few large and well found motor boats will take their place.

Delta Rays

THE name δ ray was given by J. J. Thomson in 1905 to the slow electrons emitted by polonium and which has previously masked the positive charge of the α rays. A little after Rutherford discovered a similar emission for radium and showed that it is not exclusive to the source of the α rays, but is produced by all bodies struck by these rays.

Recently Gargan and Bumstead have shown that certain rays of a sheaf of δ rays are endowed with greater velocities than those which have hitherto been measured; a retarding potential difference of 1,700 volts does not stop them. In a recent memoir Bumstead arrives at the following results: When α rays strike a metal they cause the emission of electrons of which the velocities vary progressively from a very low figure to about three thousand million centimeters per second. He proposes to call all these δ rays. At the same time there is an emission of positive ions from a metal placed in a high vacuum and bombarded by α rays: these ions seem to come from gas absorbed into the surface of the metal.

When the δ rays encounter a solid, they produce an emission of slow electrons which Bumstead calls tertiary electrons. Their number is much greater than that of the δ rays which produce them.

Engineering

The First Railroad in Iceland.—According to a dispatch from Copenhagen, a railroad 60 miles in length is to be built in Iceland. At present there is not a mile of railroad in the whole of that island; indeed, it is devoid even of good roads, as we understand the term in this country. Such roads as exist in the island are mere bridle paths.

Wood Spring Tires.—An interesting experiment has been made in England with wood spring tires which have been fitted to a one-ton motor truck. The experiment has been satisfactory as far as it has gone, as the wood blocks do not appear to have been deformed and show little signs of wear. *The Engineer* states that these results were obtained after a run of over 3,000 miles.

The Coal Fields of the Antarctic.—Prof. Edgeworth Davis, lecturing before the Royal Geographical Society, stated that he did not believe the world as yet realized the scientific as well as the commercial importance of the great coal fields which Sir Ernest Shackleton discovered at the head of the Beardmore Glacier, and which in a small strip contain probably as much coal as exists in all the unworked coal fields of Great Britain.

Tunnels Versus Bridges.—The idea that a tunnel can be compared favorably with a bridge, in point of its capacity for a given cost, is erroneous and unfortunately is very widespread. A bridge such as that proposed across the North River would accommodate six to eight times as much traffic as could be sent through a tunnel; in other words, the cost for a given amount of traffic would be very much greater for the tunnel than for the bridge.

The Father of the Dreadnought.—To the lately deceased Cuniberti, Major-General of the Italian Naval Engineering Staff, is due the credit of having first suggested the modern dreadnought. It was he, also, who suggested the modern type of scout, and he was one of the first to study the question of the application of liquid fuel to marine boilers. It was his influence which led to the adoption of this fuel in the Italian torpedo boat service.

Gatun Lock as a Dry Dock.—One of the locks of the Panama Canal at Gatun has been put to the novel use of serving as a dry dock for the overhauling of five of the submarines, T-1 to T-5, which have been stationed at the Atlantic entrance to the canal since December 12th last. The lock chambers are arranged in pairs, and it is therefore possible to use one of them as a dry dock without interfering with the passage of vessels through the other.

Panama Grows More Healthy.—The last report of the Department of Sanitation at Panama for the year 1913 shows that for the Isthmian Canal Commission and the Panama Railroad Company, out of 56,654 employees there were 473 deaths, giving a rate per 1,000 of 8.35. This is the lowest rate recorded since the United States took possession of the Canal Zone. The next lowest was in the previous year, 1912, when the rate per 1,000 was 9.18. The highest, 41.73, occurred in the year 1906.

A Transformed Tank Ship.—A sailing tank ship, "Jules Henri" of Marseilles, has recently been transformed into a motor tank ship at Wilton's shipyards in Rotterdam. The ship, which originally was 76 meters long, was cut in half after the masts had been removed, and a new section 17 meters long was built at the break. Two Diesel motors each of 500 horse-power were then installed. The transformed motor tank ship is now 93 meters long by 12.25 meters wide, and has a capacity of 3,000 tons of oil. After a first voyage to the Black Sea the ship will be employed regularly between Europe and America.

Two of the Most Recent Types of Oerlikon Steam Turbines are now running in the central electric station of Stockholm, these being of 10,000 horse-power size. Turbine and dynamo make up a compact group, and the turbines are of a new design, which is claimed to have a number of advantages, one of these being a low steam consumption of 7.9 pounds per horse-power hour. The turbines operate at 3,000 r.p.m. standard speed. Such turbines are made up as usual of blade wheels each in a separate steam chamber, but the combination of speeds and pressures within the turbine is based on a somewhat novel theoretical design.

Concrete Poles Withstood the Storm.—The great strength of reinforced concrete telegraph poles was proved to a demonstration during the violent storms of this winter. The Pennsylvania Railroad Company states that this was shown in the case of their telegraph lines, where a large number of reinforced concrete poles were exposed to the recent heavy storm, which practically isolated New York city. Though many of the wooden poles were broken down by the wind, in no case did a reinforced concrete pole fall, and this in spite of the fact that so severe was the stress that the wooden cross arms upon some of these poles were broken. They are made of Portland cement, reinforced with steel rods. They have the further advantages, in addition to their strength, that they do not rot at the ground, and that they never rust as do the steel poles.

Electricity

Marconi's Radiotelephone Experiments.—According to press dispatches, Mr. William Marconi is meeting with considerable success in his wireless telephone experiments, and is confident that transatlantic radiotelephony will be an accomplished fact at some not far distant day. Mr. Marconi has been conducting experiments from the Duke of Abruzzi's flagship, the "Regina Elena," off Agosta, Sicily, and has succeeded in maintaining radiotelephonic communication with ships from 18 to 43 miles distant. In connection with his receivers Mr. Marconi has been using phonographic recorders and has succeeded in recording telegraph signals from Clifden, nearly 2,000 miles distant, and from Canada, 4,000 miles away.

Copper Wire can now be made by an electric bath process, which is said to be very successful. A fine copper wire is connected to one pole of a battery, and is made to traverse a bath of sulphate of copper such as is ordinarily used for electro-plating, with a small amount of sulphuric acid added. In the bath is placed a heavy copper plate as the second electrode. The fine wire acts as a core and is covered with the deposited copper. Then after passing through a washing tank it is dried and runs upon a reel on which it is hardened by means of friction. The wire then returns to the plating bath and takes another layer, and so on until it has attained the required thickness. It is advisable to have the plating done by degrees and not all at once, as the metal has a better quality.

Effect of Parallel Condensers on Receiving Antennæ.—In a paper on "The Effect of a Parallel Condenser on the Receiving Antenna," read by L. W. Austin at the March meeting of the Institute of Radio Engineers, it was brought out that the practice of using a variable condenser in parallel with all or part of the inductance in the receiving antenna to receive longer waves is convenient inasmuch as it does away with the necessity of small inductance steps and reduces the total amount of inductance required but is usually found to be less efficient than pure inductive tuning. Tables showing the effects of different values of parallel capacity for two sizes of artificial antenna were shown. The readings were made with a galvanometer replacing the telephone. As the capacity was increased and the inductance decreased, the galvanometer deflection decreased. Replacing one half the inductance by capacity decreased the deflection about one third. Practically the same results were obtained with the real antenna.

The Number of Licensed Wireless Stations.—The annual report of the Bureau of Navigation, Radio Division, for the fiscal year ended June 30th, 1913, showed the following:

Class. Radio Station Licenses Issued.	Number.
Commercial, ship	145
Commercial, land	22
Special, land	17
Amateur	1,312
Total	1,496

Grade. Radio Operator Licenses Issued.	Number.
Commercial, 1st	1,617
Commercial, 2nd	315
Experiment and instruction	8
Cargo	1
Amateur, 1st	1,075
Amateur, 2nd	766
Total	3,782

Records.	
Total number of inspection records filed	3,916

Since then, up to January 10th, 1914, 465 commercial radio operators' licenses and 679 amateur radio operators' licenses were issued.

Stimulating Plant Growth With X-rays.—Experiments made by Dr. Schwartz, a German scientist, show that X-rays stimulate the growth of plants and of living tissue in general, but in order to produce good results it is required to adjust the value of the rays in order to prevent a destructive action such as can also take place without due care in making use of them. Should the exposure to the rays be too long, the effect can exceed the proper limits and become dangerous. Working upon plants, he finds that an under-exposure of 30 seconds has no appreciable effect of any kind upon the growth, and, on the contrary, a long exposure of 5 minutes is seen to alter the tissues and hinder the growth of the plant. The proper time appeared to be 150 seconds, and shortly after exposure to the rays the plants were so much stimulated that in three weeks' time they had grown to double the height of the other specimens. Such experiments were made with the use of young sprouts, and not upon plants in an advanced state of growth. As to the effect on the tissues of the human body, he finds that in the case of wounds where there is a decrease in vitality of structures, this is stimulated to quite a degree, so that, for instance, an obstinate wound will heal up after a few *séances*. It is well known that the X-rays will produce severe burns upon the skin, but this is caused by a too strong action.

Science

Killing of Two Explorers.—The Bulletin of the American Geographical Society states that there is no longer any reason to doubt the report that the explorers Harry V. Radford, of New York, and T. G. Street, of Ottawa, were killed by Eskimos at Bathurst Inlet on or about June 5th, 1912, as the result of a quarrel.

A New Estimate of the World's Radium Supply.—How large is the quantity of radium salts existing at the present time? At a lecture recently given in France, Besson placed the amount at about seven grammes. The price of a gramme of hydrated bromide of radium is about $80,000 more or less, which means that a gramme of pure metallic radium must be worth about $156,000, or in other words about $78,000,000 a pound.

A Fatigue Museum.—Mr. Frank B. Gilbreth, the well-known efficiency engineer, has started a museum of devices for eliminating fatigue in industry. The museum is in Providence, R. I. Among the exhibits to be found in the museum are factory stools and chairs of many kinds adapted to many lines of work for both men and women employees. Ultimately the museum will contain a permanent exhibit of all kinds of factory devices that affect the physical well-being of the worker. It is not limited to machine safeguards or sanitary arrangements.

The Turco-Persian Boundary has heretofore been one of the problematical features on the map of Asia. As far back as 1843, a mixed commission attempted to define this frontier with only partial success, and since that time repeated efforts have been made by the great powers, as well as the two countries immediately concerned, to complete the task, but the boundary has remained rather a zone of debatable territory than a definite line. Finally, in November of last year, a complete understanding on the subject was reached, and a protocol was signed in Constantinople in accordance with which a commission consisting of British, Russian, Turkish and Persian delegates will undertake a survey of the boundary. This is expected to require at least 18 months, and will doubtless be productive of interesting geographical results.

The Lowest Temperature Recorded in the Atmosphere.—The "record" low temperature registered in a sounding-balloon ascent is reported from Batavia, where on November 5th, 1913, the remarkable minimum of 91.9 deg. below zero Cent. (—133.4 deg. Fahr.) was found at an altitude unfortunately unknown, as the clock-work stopped during the ascent, but supposed to be about 17 kilometers (10.6 miles). On December 4th, an almost equally low minimum was registered; viz., —90.9 deg. Cent. (—131.6 deg. Fahr.), at an altitude of 16.5 kilometers (10.2 miles). In this case, the apparatus worked satisfactorily and recorded an extraordinary rise of temperature between the above-stated minimum at 16.5 kilometers and a reading of —57.1 deg. Cent. at 26,040 meters (16.2 miles); i. e., a total rise after entering the stratosphere of 33.8 Cent. or 60.8 Fahr. degrees. On August 6th, 1913, a balloon sent up at the same place showed a rise of 18.9 Cent. (34.0 Fahr.) degrees after passing the altitude of minimum temperature. In this case, the balloon rose to 22 kilometers (13.7 miles). These observations show that the name "isothermal layer," applied to the stratosphere, is sometimes a misnomer.

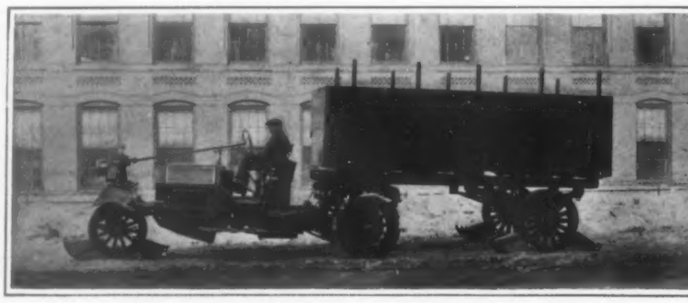
A Comedy in Antarctic Nomenclature.—Apropos of the editorial "Mawson and Wilkes," published in our issue of March 14th, it appears that American geographers have been over-sanguine in assuming that the name "Wilkes Land" was at last indelibly inscribed on Antarctic maps. As pointed out in our editorial, a British chart of 1856 shows this name in its proper place. For the past half-century, however, the backings and fillings of British cartographers concerning the name and its application have furnished diversion to Americans endowed with a sense of humor, and have been taken *au grand serieux* by others. The latest episode in the comedy (as we prefer to consider it) takes the form of a map published in our English contemporary *Nature* of March 5th, page 12. Here we find "Wilkes Land" printed where it belongs, but in type which conveys an unmistakable impression of evanescence, while immediately beneath it, spread over the same tract of land, appears in large, bold letters the name "King George V. Land." The latter name is a little over a year old, having occurred for the first time in a wireless message of February, 1913, from Dr. Mawson, who was then in Adelie Land. We believe, however, that Mawson had no intention of giving this name anything like the geographical extension indicated by the chart in *Nature*. A definite statement from him on this subject will be awaited with interest, though it can in no wise affect the validity of the earlier name. For American geographers, at least, the long stretch of the Antarctic between Victoria Land and Kaiser Wilhelm Land will remain "Wilkes Land" until the time—now, perhaps, measurably near at hand—when this portion of the Antarctic is annexed by the Commonwealth of Australia. Then, of course, we shall have to accept whatever name the Australian authorities choose to assign to it.

Motor Vehicles on Runners

ALTHOUGH it is possible with little snow on the ground to run a motor cycle with its rubber tires, it has been found impossible to do so when the fall measures several inches. A resident of Galt, Ontario, has solved the problem as shown in one of our photographs. The rubber tires were taken off the front wheel of the machine, and off the wheel on the side car, which is attached to the machine, and runners were bolted to the rims of the wheels. The rubber tire remains on the rear wheel of the machine for driving purposes, but the runner on the front wheel makes the rut, thus permitting the use of the one tire. The motor cycle has been given a thorough test, going through a foot of snow without any trouble at all.

The same idea applied to commercial use is pictured in the second photograph, which shows a three-wheeled tractor hauling a truck through the snow. Obviously, only the drive wheels need contact with the ground. The other wheels make work by crushing through the snow, and if supported on runners materially reduce the work of the motor. The runners may be applied or removed very readily. This is a good suggestion for motor truck owners to jot down for use next winter.

Motor cycle and side car mounted on runners.



Eliminating unnecessary work by the use of sled runners.

Lifeboat Test Off Sandy Hook

NEVER, probably, has greater interest been aroused in the question of lifeboat construction than at the present time. This is natural; for the loss of the "Titanic" is not so far removed, but its lessons are still foremost in the minds of shipbuilders and shipowners; and the past winter, with its unusually bolsterous weather and its exceedingly long list of wrecks at sea, in which the lifeboat has been called into constant requisition, has concentrated attention on these small craft as never before. Indeed, next to the subject of hull construction, the matter of lifeboats and their stowage was the most important that came up before the London Conference on Safety at Sea.

We present illustrations of a new type of steel lifeboat which, on two successive days last week, was subjected to severe tests in the presence of Gen. Uhler and the Board of Supervising Inspectors of Washington, D. C.

The lifeboats were designed by Capt. Lundin, and they embody the result of many years of practical experience and observation. It will be seen that they are a wide departure from what might be called the whaleboat type of lifeboat, with which we are all familiar. The craft embodies the stability and great carrying capacity of the raft with the maneuvering qualities of the standard type of boat. This was shown in a series of tests off Sandy Hook on the second day, when a 24-foot boat, heavily laden and propelled by six oars, showed a surprising turn of speed and excellent maneuvering abilities. The boats are built of galvanized sheet iron, and they consist of a decked hull with sides extending about 15 inches from the deck, and provided with weatherboards which automatically lock themselves in the upright position on being raised. When folded down, they form a firm platform to rest the second boat on, no other chocks being necessary for the top boat. An excellent feature is the provision along each side of a very thick continuous fender of balsa wood, which is flat on its inner side, where it lies against the hull, and is molded on its outside to conform with the generally rounded scow lines of the lifeboat. Balsa wood is about 40 per cent lighter than cork, and the fenders alone would assist materially in keeping the boat afloat.

The Lundin boat is of true lifeboat construction with an outer and inner floor, both of steel. The bottom is divided into numerous watertight compartments, each of which is provided with a manhole and watertight manhole cover. The inner floor, or deck, even when the boat is loaded with sixty or more persons, is well above the waterline, and each compartment is provided with drain pipes for self-clearing, equipped with floatable ball valves of a long tried pattern, which prevent the water from squattering up from below. The space provided for passengers is, therefore, self-bailing, and any spray or water that may enter the boat quickly drains away.

In the test on Saturday three boats were put through their exercises; one, a 24-foot metal boat with the Lundin features, of the general ship's boat model, but of very full body and provided with balsa-wood fenders; another, a 28-foot Lundin boat of the scow type, with double bottom; and the third, most interesting of all, was a large 30-foot power-propelled boat, provided with a large watertight steel cabin, driven by a 24 horse-power Standard motor, and equipped with a wireless outfit capable of sending messages for seventy-five miles. The power lifeboat can make six or seven miles, under power, and in the case of shipwreck is capable of taking eight or ten other boats in tow and holding them together, head to sea, and by means of its wireless, bringing up the rescuing ship. The superstructure of the closed cabin is generally semi-circular in cross section, with bulkheads closing in the forward and after ends. In each bulkhead are two large steel doors which are closed against rubber gaskets. The cabin can hold sixty or more people, and ventilation is provided by a series of hinged portholes ranged along the sides. The lower part of these portholes forms a rowlock, and the opening is just large enough to permit free movement of the oars.

The weight of the double bottom and the circular form of the cabin combine to give to these boats absolute self-righting qualities. This was proved in a test which is herewith illustrated, in which the boat was rolled over, by means of a crane, until it was bottom upward, and then released. Within two or three seconds' time it had righted, the heavy weight of the double bottom, combined with the form of the cabin, making this result inevitable. Capt. Lundin believes that a boat of this kind, even if filled with passengers, might be entirely rolled over by a breaking sea, without endangering the lives of the passengers.

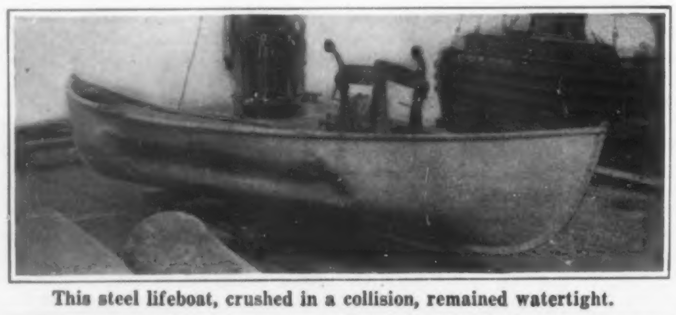
The experience already had with steel lifeboats proves that they are able to go through a degree of rough usage without springing a leak that would completely disable any wooden lifeboats.

The difficulty experienced in endeavoring to launch the lifeboats of the "Volturno," shows that the wooden lifeboat is doomed, should it be swung while it is being lowered against the side of a rolling ship, or should it, when in the water, be swept against the hull of the vessel. The wood in such a case splinters badly and heavy leaks are developed. The steel lifeboat, on the other hand, has shown that it can suffer a surprising amount of distortion and come through the ordeal watertight. One of our illustrations shows a standard metallic lifeboat on an American coast liner which

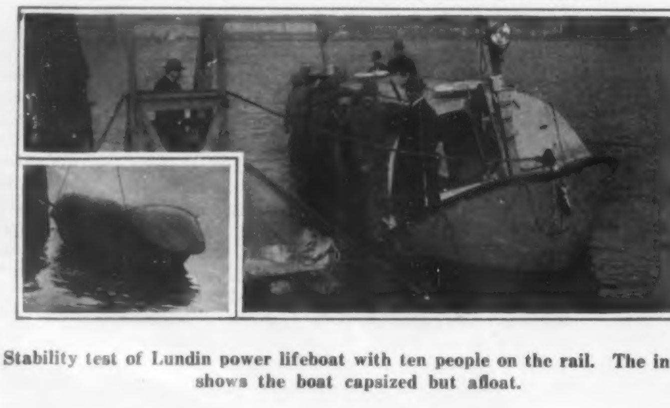
(Concluded on page 272.)

Photo by Levick.

Power lifeboat towed at 13 knots in rough water.



This steel lifeboat, crushed in a collision, remained watertight.



Stability test of Lundin power lifeboat with ten people on the rail. The insert shows the boat capsized but afloat.

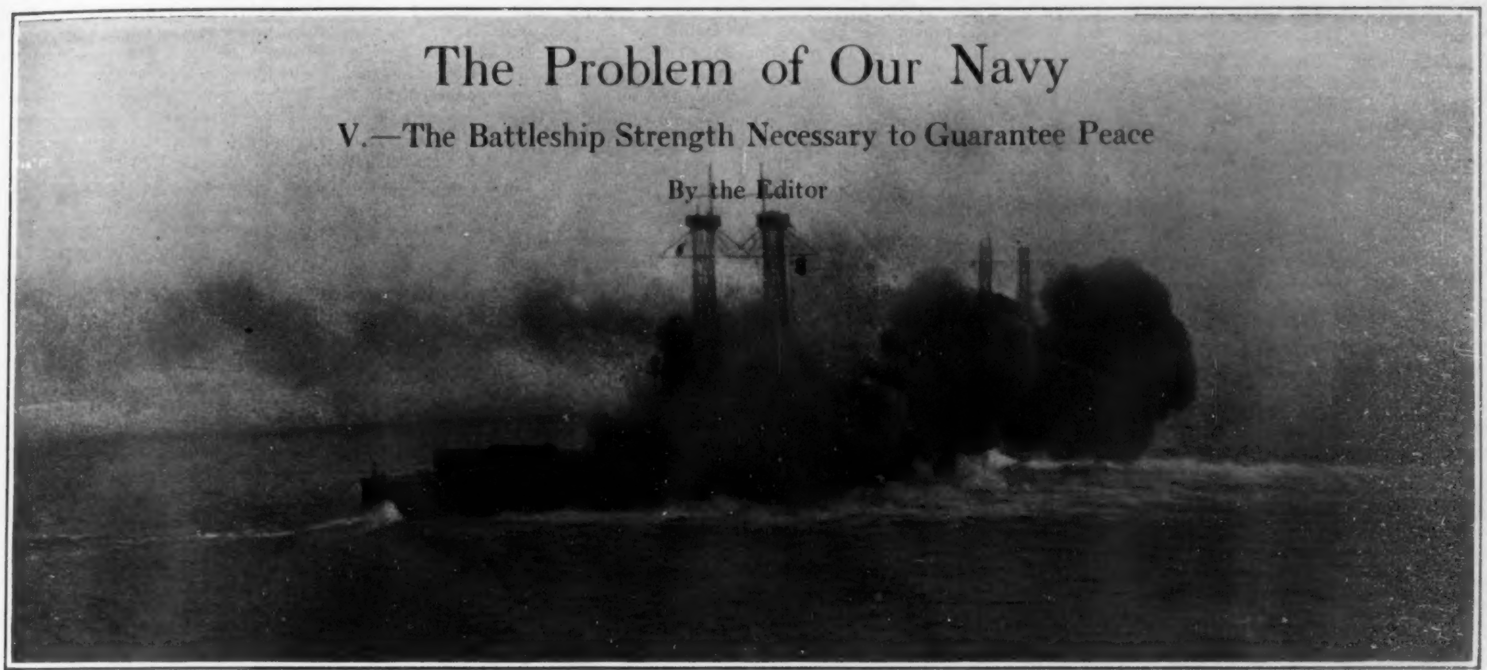
Photo by Levick.

Note the high bow, steel cabin and wireless outfit.

The Problem of Our Navy

V.—The Battleship Strength Necessary to Guarantee Peace

By the Editor



THUS far in our study of the problem of our Navy we have shown:

First, that the necessity for the creation and maintenance of a navy of the first class has been imposed upon the United States by circumstances over which this country had no control. We have seen that, although it was the dream of the Fathers of this republic to found a new nation, which, free from any entangling foreign alliances, should exemplify and perpetuate within its own borders those principles of liberty and equality which had been written into its Constitution, the day ultimately arrived—as it was bound to do—when a resistless destiny thrust this country out into that broad arena of world politics, wherein is being carried on an eternal and inevitable struggle for international pre-eminence. And it was shown, further, that by forbidding the partitioning of China, and by building and fortifying the Panama Canal we have rendered this country the very storm center of that greater struggle for commercial and naval pre-eminence, which the opening of this waterway and the development of the Orient is certain to produce.

Second, we have seen that, although our Government at first responded nobly to the call for a greater navy, and thereby showed its recognition of the fact that the day of our isolation was over, and that we must henceforth accept the burdens and exercise the functions of a great world power—of late years we have been guilty of the inexcusable folly of neglecting our Navy, and this at the very time when we were affirming our world policies with a definiteness and daring for which modern history presents no parallel. It was shown that we have curtailed our naval construction during the years when the nations that would be most likely to challenge our policies were accelerating their own naval construction; with the result that, in the event of dispute, we may have to accept the alternative of an ignoble abandonment of our policies or a crushing defeat upon the high seas.

Third, we have shown that the highly technical and specialized nature of the modern instruments of war has largely obliterated the advantage of certain mental and physical characteristics, in which our people have been pre-eminent; with the result that the issue of future wars will depend more than ever upon the possession of a preponderance of the mere materials of war—that victory in the great day of trial will lie with the fleet which can concentrate the greatest number of heavy guns in a given length of battle line. We proved, furthermore, from the past history of our country that, although the cost of a fleet of fighting ships is enormous, it is positively insignificant in comparison with the cost of unpreparedness, as shown by the fact that policies of retrenchment—that is to say, peace policies that were provocative of war—have saddled this country with an annual pension roll of $180,000,000.

Now since war, with its irreparable loss in life and treasure and its crushing legacy of an enormous annual pension roll, is the greatest physical calamity that can fall upon the country, simple common sense demands that, if any means can be found to prevent war—to insure against its losses—they shall at once be adopted.

Geographically, the United States is so situated that there is only one direction from which a first-class foreign power could wage war with any hope of success, and that is from over sea. Furthermore, no power would dream of sending its fleet over sea unless it could meet us with such a preponderance of force as to render victory certain.

The possession by the United States of a powerful and well-balanced navy, fully equipped and manned, in constant training, and with a reserve of ships and men capable of swift mobilization, would be an absolute insurance against war—IF, AND ONLY SO LONG AS, THAT NAVY WAS MAINTAINED AT A CERTAIN STANDARD OF STRENGTH WITH REGARD TO ITS POSSIBLE OPPONENTS.

"Its possible opponents;" and who are they? England? No; for we could not hope to match her enormous navy; nor is it necessary. Not only do the international interests of that country broadly coincide with our own (the Monroe Doctrine, for instance, was proclaimed with her approval and still receives her moral support), but both the British government and its people are distinctly friendly in their attitude to the United States. In witness whereof, take note of her patience in the matter of the Panama tolls, and her admirable self control and tact in the delicate situation brought about in Mexico by the killing of one of her subjects—a kind of international episode in which it has ever been her policy to strike with a swift and unsparing hand.

With the British Navy eliminated as a standard of comparison, we come to that of Germany. Is Germany a possible opponent, and must we match her navy ship for ship? She is, and we must. And we say this in a spirit of the most friendly appreciation of that great country and the genuinely pacific spirit of its present Emperor; and in the belief, moreover, that the Germans, like ourselves, would deplore any such deadlock between our national policies and their own as would call for the stern arbitrament of war.

Now it is a fact, well understood in diplomatic circles, that the whole of Continental Europe, and Germany in particular, regards the Monroe Doctrine with—well, to put it gently, with no friendly eye. The last-named country has vast and rapidly-growing commercial and industrial interests in the Latin-American republics and in South America. It is consistent with the proud, exclusive and self-assertive spirit of the German that he should wish to deal with any complications which might arise in those countries, directly—with the "mailed fist" let us say—rather than by proxy, as in the present Mexican crisis.

And across the Pacific lies that vast Empire of China, fabulously rich in its undeveloped resources, and a tempting prize for the greater European powers, as the events following close upon the Japanese-Chinese war so clearly proved. England, Germany, and France would have created "spheres of influence"—a phrase which, translated into its literal meaning and inevitable consequence, means partition and possession. As against this, we have proclaimed the policy of the "Open door" and "The integrity of China." Add to this the fact that we stand guard (with "mailed fist" if you please) at both portals of the key to the whole naval and commercial situation—the Panama Canal—and it will surely be evident that the United States should hasten to restore her navy to the second rank which it held in 1905, when it showed a positive superiority in strength over that of Germany, our possible opponent.

The question of the strength of a navy is a purely relative one. Our navy is strong or weak, solely in its relation to the strength or weakness of the navies of our possible competitors. The champion wrestler of the village green finds that he is a mere novice in the nearest town, and the subject for jeers and laughter in the arena of a cosmopolitan city.

The citizens who, in October, 1911, gazed upon the fleet of 127 ships, including 31 first-class battleships, strung out in the Hudson River from Spuyten Duyvil to Forty-second Street, were not to be blamed if they believed that fleet to be a mighty aggregation of ships and men, ready and able to steam out past Sandy Hook and crush any fleet that could be sent against it. But if they had been told that the German fleet would have reached from Spuyten Duyvil to Staten Island, and the British fleet to Sandy Hook, they would have realized that naval strength, like the skill of the village wrestler, is strictly relative.

Many years ago there was created a General Board of the Navy, with Admiral Dewey at its head, for the express purpose of studying this question and drawing up a programme of construction, which, if strictly followed, would maintain the United States Navy at such a standard of strength, that this country could pursue its policies without any fear of challenge or attack. If this policy had been followed, the nation, in 1920, would have possessed a battleship strength of forty-eight, with the necessary cruisers, scouts, destroyers, submarines, colliers and supply ships in proper proportion.

"Such a policy," says a distinguished naval authority, "would have fulfilled all the necessary conditions; would have kept the Navy of the United States second to one only; *would in my firm conviction have discouraged the world race in armaments and ultimately tended to their reduction; and most assuredly would have tended to world peace;* for we have no blow to strike ourselves, and however strongly questions of race expansion, trade rivalries, and conflicting interests might urge other nations to strike us, the blow would never be struck, if we possessed a fleet which insured their defeat."

And what became of this programme? It went into the archives of the Government, and there it slumbers to this day. And there it is destined to lie until the breath of life is breathed into it by the will of the people as expressed through their representatives in Congress.

The Naval Board programme was never adopted. In the give-and-take of politics this, the most vital question affecting the welfare of the nation, was thrown into the political bag in common with such relatively minor matters as rivers and harbors, pensions, good roads and a hundred measures of purely local interest, and it came out of the shuffle cut down to a yearly quota of two battleships per annum. And in four out of the past eight years even that modest programme has been cut in half.

Hence, if we are to retain our former standing, we must not only build up to the standard set by the Naval Board, but we must increase the yearly addition by the number of ships omitted. To bring our fighting line up to a standard of strength which will deter Germany from risking a conflict for the control of the Caribbean, we must build six dreadnoughts per year for the next three years and two or three per year for the years immediately following, carrying on this policy until Germany, realizing the hopelessness of any successful challenge of the Monroe Doctrine, shall desist.

For it is a fact, too little understood by our Congress, that the ambitious German naval programme, inaugurated a few years ago, was aimed, not at England, but at the Monroe Doctrine. Had we maintained the lead

which we held in 1905, Germany would never have attempted to outbuild us, England would never have taken alarm at German activity, the added increase in her own and the German programmes would not have been made, and the so-called race in armaments would never have begun.

It takes four years to build a battleship and train her crew to full efficiency. If we build six battleships a year in 1914, 1915, and 1916, we shall have a first line of battle of 30 dreadnoughts in commission in 1920, and a second line of 16 pre-dreadnoughts. In that year Germany will have a first line of 36 dreadnoughts, of which 11 will be battle-cruisers of lighter gun power and less heavily armored than our battleships, she will have a second line of 15 pre-dreadnoughts. In a struggle for the command of the Caribbena, we would be operating within easy reach of naval bases—Germany would be nearly 4,000 miles from her own. The odds would be decidedly in our favor; and under such conditions Germany would not risk the loss of her fleet in a great naval war. She would never send her fleet across the Atlantic, except with a preponderance of naval force so great as to insure a certain and sweeping victory.

Similarly, if our exclusion of the Japanese brought on a war with Japan, involving a contest for the possession of the Philippines, we would be operating at a great distance from our naval bases, and, like Germany, should require a preponderance of naval force to insure success.

Battleships are cheaper than battles, and the building of six dreadnoughts per year for the next three years would place us in a position which would effectually discourage the present race in armaments, maintain our policies beyond all fear of challenge, and preserve the peace indefinitely.

But the cost! Six dreadnoughts per year for three years would mean a total of eighteen. The $180,000,000 pension bill for the present year alone would cover the cost.

Suggestion for Proviso High School

THE editor of this newspaper is a constantly delighted reader of the SCIENTIFIC AMERICAN, which is authority on American mechanics. We have often thought how beneficial and interesting it could be made if added to the studies in high schools. Supposing that all the classes of the Proviso High School could be assembled at a stated hour on each day, and the principal, or a student chosen by him, would read an article from the AMERICAN, and discuss or elaborate on the subject treated, how it would be tapping a great mine of knowledge, for the benefit of the students. In the last issue is an article on the manufacture of automobiles, in the parts of which exact accurateness must be attained. It is intensely interesting and instructive. The vital part of an automobile is its piston, and the AMERICAN describes the making of it in the following simple and delightful language:

"The paper upon which the SCIENTIFIC AMERICAN is printed measures three one thousandths of an inch in thickness, a measure too small to be observed with the naked eye. Yet an automobile manufacturer would hold up his hands in horror if you showed him a piston or cylinder that varied from his standard by anywhere near that amount. Split this paper into six leaves; wrap one of the leaves around a piston of standard measure and you will have increased its diameter by only one one thousandth of an inch. If then you could insert this piston into its cylinder, the cylinder would probably be rejected as too large, or if accepted, you would be informed that it represents the absolute limit of departure from perfect accuracy. We are accustomed to saying that there must not be a variation of a hair's breadth, believing that to be the acme of accuracy, but a hair's breadth may be three one thousandths of an inch or more, whereas in the important part of an automobile motor, one one thousandth of an inch represents the extreme variation permissible, and some parts have to be ground down to within half of a thousandth of an inch."

The article from which we quote is as intensely interesting throughout as is this excerpt. And there are a dozen leading articles equally as fine, treating of life, nature, science, mechanics and kindred subjects which would be prodigiously valuable and beneficial to the students of our high school. And it is so with every issue of the SCIENTIFIC AMERICAN.—*The Advocate* of Melrose Park, Ill.

The Flight Around the World

ALAN R. HAWLEY, president of the Aero Club of America, states that substantial assurances have been received from the Panama-Pacific Exposition of the *bona fides* of the offer recently made for a successful flight around the world. The $150,000 in prize money offered by the Exposition is actually on deposit in a San Francisco bank. The time for the race has been extended from 90 days to 120 days, and if no aviator wins the race before the expiration of that time, all those still in the air will be allowed to continue flying, and will be credited as winners in the order of their arrival, with certain penalties for each day they fly beyond the established limit. Supply stations three hundred miles apart will house gasoline, castor oil, and mineral oil. Aeroplanes may be shipped over the Atlantic provided any of the contestants feel that they do not care to engage in the hazardous feat of crossing the ocean. The original route from Asia to the western coast of North American has been abandoned, and in place of it by way of the Commander Islands has been decided upon with Sitka, Alaska, as the first landing place on the North American continent after leaving Asia. Several cities have offered sums of money for the privilege of being designated as landing places.

The Coin Problem

THE "Problem of the Mint," discussed in our issue of February 7th by Theodore L. De Land, has drawn forth many answers. This problem may elicit a variety of replies. The following arrangement by Salem F. Kennedy is designed to point out the considerable variety of answers to Mr. De Land's query:

Let $x, y, z, \ldots s, w, m,$ equal respectively the number of pieces of each minted value. Then

$$x+5y+10z \ldots 500s+1000w+2000m = 50000 \quad (1)$$

$$\text{and } x+ y+ z \ldots s+ w+ m = 200 \quad (2)$$

Multiply (2) by 250, subtract from (1), transpose and factor, and $249x + 245y + 240z + 225u + 200v = 250(s + 3w + 7m)$ (3)

The total value of the first member of this equation must have a factor of 250, since the second member has such factor. By simple inspection the first member (3) may be reduced to a multiple of 250 by assigning values to x, y, z, etc., as follows:

$x = 10$	2490
$y = 4$	980
$z = 2$	480
$u = 2$	450
$v = 3$	600
21	5000

Substituting 5000 for the first member and dividing (3) by 250, we have $s + 3w + 7m = 20$. $s = 3$, $w = 1$, $m = 2$ satisfies this equation. Whence the following number of pieces, and the total value, affords an *average* of $2.50, which is one of the conditions precedent. They are as follows:

A.	$x = 10$, value	$0.10
	$y = 4$, "	.20
	$z = 2$, "	.20
	$u = 2$, "	.50
	$v = 3$, "	1.50
	$t = 1$, "	2.50
	$s = 3$, "	15.00
	$w = 1$, "	10.00
	$m = 2$, "	40.00
	28	$70.00, average $2.50

The number of pieces required being 200, this result must be increased by 172. By the familiar rule of alligation, comparing u, v, s, w, we have:

$$u : s :: 10 : 9$$
$$v : s :: 5 : 4$$
$$u : w :: 10 : 3$$
$$v : w :: 15 : 4$$

The number of pieces of u, v, s, w may be increased as follows:

$$(u + s) = n(10 + 9) \quad (4)$$
$$(v + s) = n(5 + 4)$$
$$(u + w) = n(10 + 3)$$
$$(v + w) = n(15 + 4)$$

for any value of n.

If n equals 1, 2, 3, 4, etc., we must have:

B.
$$u + s = 19, 38, 57, 76, \text{etc.}$$
$$v + s = 9, 18, 27, 36, \text{etc.}$$
$$u + w = 13, 26, 39, 52, \text{etc.}$$
$$v + w = 19, 38, 37, 76, \text{etc.}$$

By the arrangements of A and B, and the "little joker" t (the $2.50 coin), at least 100 different correct answers to Mr. De Land's problem may be written out at once. It is seen that arrangement A lacks 172 pieces that will average $2.50 each. The t value will supply the demand; giving the number of pieces substantially as in form A, with the exception that t will equal 173 instead of 1. Again, $10u + 9s$ produces the average, which added to collection A, leaves $153t$ to be supplied. Formula B may supply a very great number of substitutions, giving decidedly different results in each case, and all strictly correct. An exhaustive search will doubtless reveal correct answers into the hundreds.

Strictly speaking, there is no such thing as an algebraic formula for these problems. They all depend for solution on ingenious arrangement and close inspection.

Sir John Murray

FULL of years and honors, the marine biologist and oceanographer, Sir John Murray, met with sudden death on the 16th of March. Born and partly educated in Canada, he had passed most of his life in Scotland, and was one of the most conspicuous figures in the scientific world of Great Britain. He had celebrated his seventy-third birthday on March 3rd.

In the history of oceanography, especially on the biological side, two names are pre-eminent; Alexander Agassiz and John Murray. Agassiz, the Swiss-born American, collaborated in the task of placing before the world the epochal results of the "Challenger" expedition; and Murray, who took part in that expedition and edited nearly the whole of the fifty-volume "Challenger" report, paid a graceful tribute to the memory of his former colleague when, during a recent visit to America, he intrusted the National Academy of Sciences with a fund for awarding an "Agassiz medal" to persons distinguished in oceanographic research.

The "Challenger" expedition, which in the years 1872-76 carried out no less than 68,900 miles of deep-sea exploration, was the foundation of oceanography as a coherent branch of science. The submarine world was then, for the first time, revealed in a comprehensive way to the insight of man; and this voyage has accordingly been pronounced the most momentous geographic undertaking since the voyages of Columbus and Magellan. Murray, who had previously visited the Arctic regions in a whaler for purposes of biological research, was one of the two naturalists on the "Challenger" under Wyville Thomson, chief of the scientific staff. The failing health of the latter, and his death in 1882, resulted in throwing the whole burden of superintending the publication of the scientific results upon Murray. The execution of this formidable task, as well as his individual contributions to the great report, at once placed him in the front rank of marine investigators.

Thereafter, as the recognized leader in his field, he was obliged to bear the burden of public and private duties which always falls to the lot of the eminent specialist. He found time, however, for numerous researches on his own initiative, including expeditions to explore the Faroe Channel in 1880 and 1882; was a frequent contributor to scientific journals; and received abundant honors, culminating in the K.C.B. in 1898.

The greatest work of Murray's latter years was the execution, with the aid of able collaborators, of a bathymetrical survey of the fresh-water lochs of Scotland, the results of which were published in six volumes in 1910. In the latter year he induced the Norwegian government to send the exploring ship "Michael Sars" on a cruise of the North Atlantic, which proved to be one of the most fruitful enterprises of its kind ever undertaken. Murray defrayed the expenses of this cruise and took part in it. The results of this voyage furnished the bulk of the material for the splendid compendium of oceanography, "The Depths of the Ocean," published by Murray and Hjort in 1912.

It may be worth noting, merely as a curious observation, that Sir John Murray owed a little of his celebrity to the fact that he had numerous prominent namesakes. At the beginning of the present year there were living no less than nine "John Murrays" important enough to be included in "Who's Who," and it can hardly be doubted that each of them shone, to a greater or less extent, with light reflected from the others, since they all contributed in making their common name familiar to the public. The most eminent survivor of the nine is, probably, the London publisher, fourth of his name and line.

The Current Supplement

IN this week's issue of the SCIENTIFIC AMERICAN SUPPLEMENT Dr. H. Lieber gives an account of the manufacture and uses of Blaugas.—Dr. L. H. Baekeland writes on the history of celluloid.—Dr. H. Lyster Jameson reports on recent advances made in the investigation of the cause of pearl production in oysters, and shows how such production has been artificially induced.—Our Paris correspondent contributes an article on prehistoric flint mines in Belgium.—Petroleum, its origin and its derivatives, is the subject of an article by D. T. Day.—W. P. Davey gives an excellent review of the present status of our knowledge of X-rays.—Prof. H. Geiger's method of counting alpha and beta particles is described by its author.—The subject "Curbing the Mississippi" is treated by J. R. Crowe.—The ocean-going, oil-burning, steam yacht "Cyprus," a remarkably fine vessel, is illustrated and described.—C. L. Foote writes on the use of concrete for roads.—The second instalment of G. A. Shook's article on Quantitative Colorimetric Analysis appears in this issue.

The Death of Dr. Edward S. Holden

DR. EDWARD SINGLETON HOLDEN, librarian at the United States Military Academy, died on March 16th, after an illness of some years duration. He was president of the University of California from 1885 till 1888; director of the Lick Observatory, 1888 to 1898. In July, 1902, he became librarian at the United States Military Academy.

Dr. B. E. Fernow, dean of the forest school of the University of Toronto, and Bristow Adams of the United States Forest Service, have just been elected president and secretary, respectively, of the Society of American Foresters, the only organization of professional foresters in the western hemisphere.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

The Shuman Solar Power Plant

To the Editor of the SCIENTIFIC AMERICAN:

Mr. Frank Shuman, in his letter on "Feasibility of Utilizing Power from the Sun," published in your issue of February 28th, makes the statement: "Our method of generating heat from the sun's rays . . . has already reached an efficiency of 57 per cent." A little further on in his letter he states that the area of sunlight intercepted by the "absorbers" at his Cairo plant is 13,269 square feet, and that they develop 50 horsepower throughout a ten-hour day.

The total amount of energy reaching the earth from the sun is now generally accepted as being nearly two horse-power per square meter of surface perpendicularly exposed to the sun's rays. Allowing for the absorbtion of the atmosphere, at least one and one quarter horse-power is available at the earth's surface. Now as 13,269 square feet is approximately equal to about 1,232 square meters, the energy received by Mr. Shuman's "absorbers" while the sun is shining is equivalent to about 1,540 horse-power. I should like to know how Mr. Shuman figures out that 50 is 57 per cent of 1,540.

The little sun-motors with which John Ericsson experimented in New York during the seventies attained a far higher efficiency than Shuman is getting at Cairo, according to his own figures; yet Ericsson never claimed an efficiency of anything like 57 per cent.

Philadelphia, Pa. E. J. D. COXE.

Sir Henry Blake on the Rubber Congress

To the Editor of the SCIENTIFIC AMERICAN:

At the International Rubber Exhibitions of 1908 and 1911 papers were read by planters, chemists, and manufacturers on everything connected with the production of rubber, and discussions followed that brought to bear the experience of experts from every rubber-growing country in the world. Those papers and discussions were fully reported and reproduced in two books that remain valuable works of reference on every question connected with the industry, in which is engaged so many millions of capital.

As the Fourth Rubber Exhibition and International Rubber Congress opens on the 24th of June, I shall be glad if any persons who desire to read a paper on any subject connected with the growing, curing, or manufacture of rubber, or the possible expansion of its uses, or to take part in the discussions, will kindly communicate and register their names as early as possible with the honorary secretaries of the International Rubber Congress, 75 Chancery Lane, London, W. C.

HENRY A. BLAKE, G. C. M. G., *President*.

Youghal, Ireland.

The Problem of Our Navy

To the Editor of the SCIENTIFIC AMERICAN:

The armaments, whether naval or military, which at some period in civilization would be a great waste, may be the greatest necessity a few years prior to that period. Who can say that the progress of the world has not at times been checked by the failure to preserve social development by an adequate protective force? And whether such a social growth is checked or crushed by a crude or a developed people, the loss to the world is beyond computation.

That human and property rights must be respected and protected is elementary. On all sides in every country we see conventions which prescribe the rules for human conduct, and because public opinion is insufficient to enforce these conventions, statutory laws are enacted prescribing penalties for their violation. And the people have learned that in a country the enforcement of such a penalty cannot be left to the public in general or to chance, but very definite rules must be made governing the enforcement of the penalty. This has been our experience under the very best conditions where the vast majority of the people have the same standards and ideals. And yet many of the people to whom these facts are simple truths tell us that public opinion is altogether sufficient to regulate intercourse between the nations and foreigners whose standards customs and ideals have developed along divergent paths.

That the force of public opinion is growing cannot be questioned, but at the same time it must be admitted that it has not reached such a unitary development among the people of this world as to make it sufficiently uncomfortable for the individual who has transgressed. It would appear to be unsatisfactory to rely on public opinion to prescribe the rules of law between the countries of the world and their citizens, but we have little else to follow, for the rules of international law and the treaties cover only a few of the questions which may arise. While it consequently may be difficult to determine what the law should be in a given case, a much greater difficulty may be experienced in enforcing the law should an accepted rule be thought to apply. Each of the contending parties would have its national police consisting of army and navy, but the international tribunal which may render judgment in a court of arbitration cannot call on an international sheriff to carry out the judgment.

With the advent of an international sheriff the situation will be changed, for it will be possible to settle the disputes even when people may be unable to see justice in a rule prescribed by a majority of States with whose traditions the people are unfamiliar. But while we are working for the international sheriff, we must protect our physical and industrial development, if necessary by arms, in order that the finer things in our character may have a rich field in which to grow.

Tenafly, N. J. EVERARD B. MARSHALL.

Flying Around the World

To the Editor of the SCIENTIFIC AMERICAN:

While the writer agrees with your editorial of February 14th on "Flying Around the World" in that the $300,000 in prizes offered for the feat by the Panama-Pacific Exposition directors could be better devoted to aerodynamical research, yet that is also true in regard to many aviation prizes of the past, and it is hardly within the province of the Exposition directors to foster aviation so directly, although we will all agree that some one or several with the means should do so. Yet is it not appropriate that an exposition to represent the entire world's progress should offer a prize for such a trip around the world? However, it should not be compulsory that the same machine or engine be used throughout the trip, although an extra prize or first prize might well be offered for this.

The writer believes that the transatlantic flight for which Lord Northcliffe offers $50,000 is accomplishable with some of the present aeroplanes, with some changes and additions, and that this flight will be accomplished this year; also, that the round-the-world trip can and will be attained next year if certain advanced principles of aviation making for efficiency and safety are carried out; for it requires an average flight of only 200 miles per day to cover the distance of, let us say, 18,000 miles in the 90 days allowed; and some of the minor prizes for partial success are surely worth while also.

In regard to the transatlantic flight, the futility of attempting it with enormous, unwieldy, untried aeroplanes, as some propose, should be apparent. But suppose we take one of the most efficient of the present aeroplanes in regard to useful weight-carrying per horse-power and miles covered per gallon of gasoline. It should have two propellers of large diameter and slow speed of revolution, besides variable angle of incidence and blades inclined slightly forward for further efficiency, the increased amount of undisturbed air acted on in the flaring slip-stream of such a propeller more than compensating for the small loss from the slight angle of the thrust, as demonstrated with the celebrated Garuda propeller of Europe. The propellers should, of course, revolve balancedly in opposite directions by means of a single chain (as can be easily arranged). Then let us add another engine and the other set of such propellers, locating the latter above and below center, with clutches for shifting either engine to either set of propellers. The machine should, of course, be a hydroaeroplane, and for safety there should be lateral resistance surfaces co-operating with the rear vertical rudder for steering, but no fixed horizontal-rudder surface; while an automatic balancing device—instantly suspendable, however, might be added to relieve the aviator when tired.

The writer is convinced that a safe aeroplane of more than twice the present greatest efficiency can be made; in fact, aerodynamic experiments already made show that this is possible to-day, and it seems more than probable that such a machine will win the prize for the round-the-world flight next year.

Livermore, Cal. ELMER G. STILL.

[NOTE.—Since this letter was written, figures in the "World Flight" have been changed, as shown on another page.—EDITOR.]

Science in the Class Room

To the Editor of the SCIENTIFIC AMERICAN:

I have noted with much interest your recent editorials on the use of the SCIENTIFIC AMERICAN in the schools. Your letter of recent date asking for further particulars with regard to our use of your journal is also at hand.

A single illustration will serve to make clear our method of using the illustrations. You have in the issue for December 27th an article on the building of foundations with hollow steel piles, concrete, and compressed air. I used this article with my class in physics as a further illustration of some work on the uses of compressed air which we had just finished. With the exception of Fig. 2, all the illustrations gave excellent results when projected on the screen with our balopticon. Fig. 2 has no sharp contrasts and the pile driving machinery in the background did not come out clearly.

The present tendency in nearly every branch of science teaching is to break away from the nicely formulated, mathematical features of the subject and to give more attention to those applications in daily life which continually meet the student. The botany class no longer memorizes long lists of classifications. Instead they are taught life processes and the effects produced by fertilizers and cultivation. Chemistry has ceased to be a series of test tube phenomena and relates itself directly to foods, sanitation, and the industries. More practical plumbing and fewer problems solved by using complicated formulæ, is the slogan of the forward movement in physics.

Many schools are demanding a text-book in physics which shall be particularly fitted for girls. Teachers are trying to fill the need by introducing such practical problems and illustrations as are found at hand. There is, however, a grave danger in collecting such material. To quote from the preface of a recent text-book: "To eliminate or minimize the fundamentals while attempting to teach their applications is not to provide a 'royal road to learning,' but a fool's highway to pretentious ignorance. Pure and applied science are equally essential to a well rounded course. The one alone is barren; the other, when not well founded in the first, is superficial, disconnected, and trivial."

The SCIENTIFIC AMERICAN is a type of journal which furnishes thoroughly reliable supplementary material. Not only is it practical, but the treatment is scientifically accurate. With a modern opaque projection, the teacher has at hand a powerful aid to class instruction in any subject. A few well chosen pictures projected on the screen make the text-book material concrete and show at a glance the various commercial and industrial applications. A good many students will be stimulated by such discussions to read further along such lines.

Nearly all the illustrations appearing in the SCIENTIFIC AMERICAN will give good results with an opaque projector as they stand. Where the print is too dark or the contrasts are not sufficiently sharp, the portions to be brought out can be covered with Chinese white and painted over with water colors.

The following is a suggestive list of some of the topics which the writer has found helpful in high school:

1. Aviation. No text-book in physics gives an adequate description of this subject. A few minutes with the files of the SCIENTIFIC AMERICAN will provide ample material for one or more lectures. Nearly every issue contains one or more illustrated articles.

2. Air Pressure and the Atmosphere. Air Lock, November 30th, 1912. Pneumatic Tampers, December 7th, 1912. Whistling Buoy, December 14th, 1912. Insufflation Apparatus, December 28th, 1912. Pneumatic Elevator and Grain Lift, July 19th, 1913. Steel Pile Driving, December 27th, 1913. Novel Uses of Compressed Air, July 5th, 1913. Soot and Dust Fall, January 17th, 1914.

3. Automobile and Gas Engine. The annual motor numbers, and following issues: Farm Tractors, June 7th, 1913. Diesel Engine, September 20th, 1913.

4. Bacteriology. Vaccine, June 14th, 1913. Typhoid Fly, July 13th, 1912. Pasteur Institute, December 27th, 1913.

5. Cement and Concrete. Cement and Its Uses, SUPPLEMENT, March 18th, 1911. Application to Waterways, April 26th, 1913. Trench and Tube Method, March 29th, 1913. Assuan Dam, February 18th, 1913.

6. Electricity. Steel Furnace, June 7th, 1913. Electric Welding, December 1st, 1913, to November 22nd, 1913. Dussaud's Cold Light, May 31st, 1913. Safety Lamp, January 25th, 1913.

7. Heat. Solar Power Plant, January 25th, 1913. Liquid Helium, December 27th, 1913.

8. Hydro-electric Plants. Mississippi River, August 10th, 1912, to September 13th, 1913. California Plants. SUPPLEMENT, August 2nd, 1913.

9. Hydrogen. Manufacture for Balloons, December 13th, 1913.

10. Oxygen. Oxyacetylene Torch, June 14th, 1913, to October 18th, 1913. Living Animals Transported by Oxygen, January 21st, 1911. Pulmotor, February 1st, 1913.

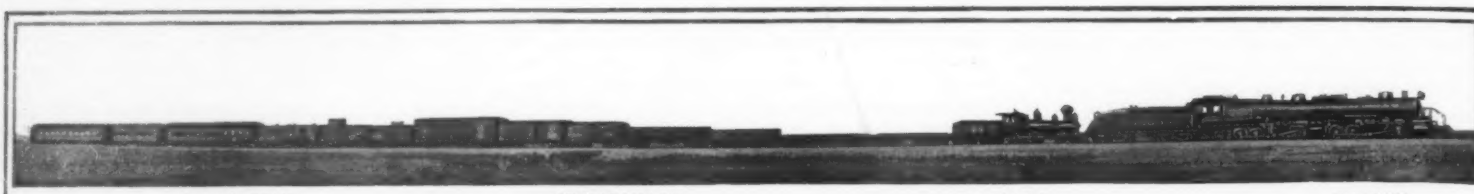
The *Reader's Guide* to the current periodicals will furnish a list of all articles on these or other subjects in which the teacher or students are interested.

An occasional article treating some industry from the point of view of the chemistry and physics involved, well illustrated and written in a simple, direct style, would attract our students. The natural growth in the circulation of the SCIENTIFIC AMERICAN resulting from such excellent reading habits being formed early in life is obvious.

May I suggest that if you find it practicable to take up such work, your assistants would find it advantageous to experiment a little with opaque projections?

RAY W. KELLY.

Pacific Grove High School, Pacific Grove, California.



RELATIVE WEIGHT

	Old equipment	New equipment
Locomotive	123,000 pounds	860,000 pounds
Flat car	19,300 pounds	33,100 pounds
Coal car	22,000 pounds	36,800 pounds
Stock car	28,000 pounds	42,200 pounds
Box car	22,000 pounds	40,800 pounds
Way car	22,000 pounds	30,000 pounds
Smoker	48,400 pounds	119,100 pounds
Coach	50,300 pounds	132,100 pounds

RELATIVE CAPACITY

	Old equipment	New equipment
Locomotive	14,000 pounds drawbar pull	110,000 pounds drawbar pull
Flat car	40,000 pounds	80,000 pounds
Coal car	50,000 pounds	80,000 pounds
Stock car	40,000 pounds	80,000 pounds
Box car	40,000 pounds	80,000 pounds
Smoker	20 passengers	85 passengers
Coach	45 passengers	73 passengers

RELATIVE COST

	Old equipment	New equipment
Locomotive	$7,740.00	$45,000.00
Flat car	300.00	942.00
Coal car	330.00	1,096.00
Stock car	480.00	1,462.00
Box car	475.00	1,265.00
Way car	620.00	1,222.00
Smoker	3,000.00	12,124.00
Coach	3,000.00	12,620.00

ENGINE 3009

Santa Fe Type Mallet Compound.
Largest Locomotive in the World.
Built at Topeka Shops, 1911.
Length 120 feet 7¾ inches.
Cylinders 28 in. x 38 in. x 32 in. stroke.
Steam pressure 225 pounds.
Capacity of tender 12,000 Gals. Water, 4,000 Gals. Fuel Oil.

Santa Fe demonstration train, showing the old (1881) and the new (1911). This shows the increase in the weight of equipment to which the airbrake was successfully adapted.

George Westinghouse

A Great American Inventor

IN the annals of industry it would be difficult to find a personality that fulfills the popular ideal of an inventor so completely as the late George Westinghouse. He began life as a poor boy; he died a wealthy man, thanks to his own efforts. His was a strong, hopeful, fighting spirit, and to it he owed as much of his remarkable success as to his wonderful intellectual gifts. The perusal of his life must ever be an encouragement to characters less forceful than his. He began inventing while he was still a school boy; he succeeded brilliantly before he was thirty; he braved what seemed to be invincible opposition, and triumphed; he surmounted all the obstacles which, from time immemorial, all revolutionists—and he was a great revolutionist in modern industry—must surmount if their ideas are to be carried into effect.

Students of eugenics will find in Westinghouse's parentage evidence enough to support their views that great intellectual ability is an inheritable characteristic. He was born on October 6th, 1846, the son of an inventor and of a manufacturer of agricultural implements. He was brought up in an atmosphere that was well calculated to foster in him that marvelous ability which he later displayed. Even as a school boy in Schenectady he worked away in his own little shop or in his father's works. At fourteen he had made a model of a rotary engine—a harbinger of the steam turbine with which his name was to be linked in later life.

There is something inspiring in the way that he bounded along to success when he could hardly have put aside his knickerbockers. At seventeen a cavalryman on the Union side in the great rebellion, and a few months later nothing less than an assistant engineer in the United States Navy! It reads almost like a novel.

What his mentality must have been when he was just old enough to vote, one gathers from his abandonment of a classical course in Union College. "You are wasting your time here," the president of that institution said to him. "A classical course is nothing for you. You know all that you can learn here of mathematics. You have a genius for invention. Cultivate it and you will become a great engineer. The college is holding you back." And so he left college and pursued his way alone. Had he started life in our day he probably would have listened to the lectures of great professors in one of our higher technical institutions; but in those days there were no technical schools in which a man of his caliber could learn anything of real technical worth.

It was not long after he left Union College that he invented the airbrake, with which his name is more tenaciously connected than with any other of his numerous inventions. The idea came to him, it is said, as the result of a head-on collision between Schenectady and Troy, which he witnessed.

Obviously meritorious as the invention was, railways

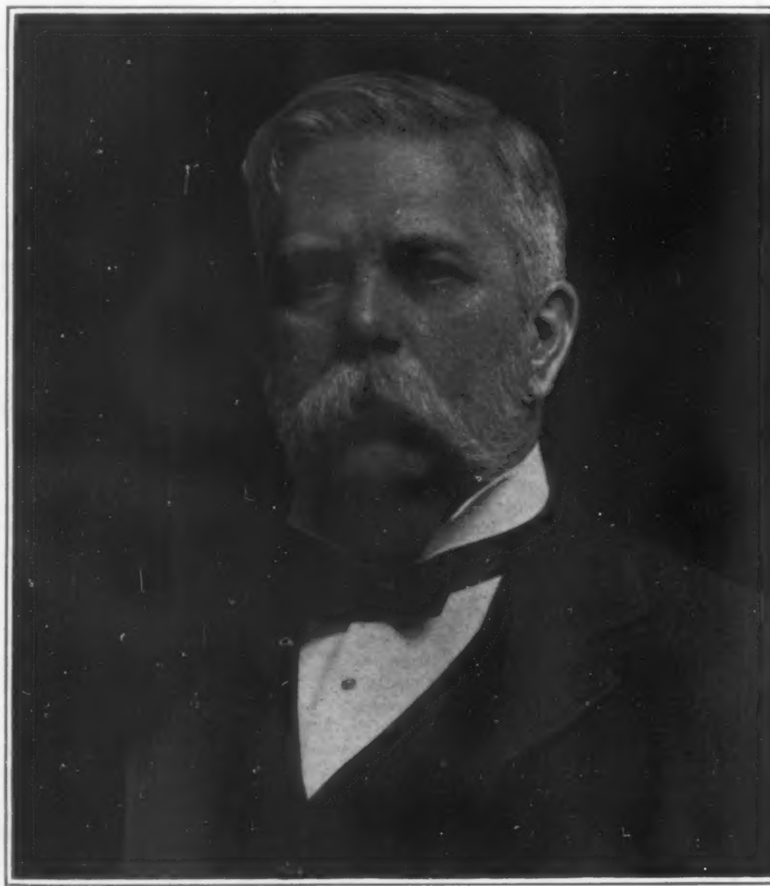


Photo. by Gessford.

The late George Westinghouse.

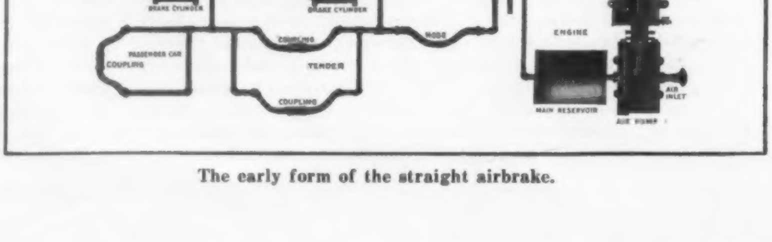
would have none of it. Every great invention means a great revolution. Revolutions in industry or transportation are no more relished by presidents of manufacturing companies and railways than a Czar relishes nihilist bombs. Westinghouse had to stub his toes more than once in kicking the brick that is concealed beneath the high hat of prejudice, against the "it can't be done" attitude of most so-called business men. He succeeded because he brooked no resistance, because he believed in himself and in his invention. An inventor who is a pessimist is doomed to failure. Mr. Ralph Bagley pledged himself to pay the cost of the first airbrake apparatus that was ever installed on a railway train. But if it had not been Mr. Ralph Bagley it would have been some one else. Tradition has it that the first trial of the Westinghouse airbrake was quite unpremeditated. The train on which it had been mounted rounded a curve; a heavily loaded wagon was wedged in the tracks dead ahead of him; the distance was so small that the ordinary handbrakes could not possibly stop the train in time; only the new airbrake, hitherto untried in actual practice, could possibly avert a disaster. The passengers were thrown out of their seats; for the first time in history a train had been stopped by air, and the first safety appliance in modern railroading proved its worth.

Westinghouse was only twenty-two then. That initial success, infinitely more convincing than a hundred successful experiments before critical and skeptical railway officials, started him on the road to success. The Pennsylvania was the first railway to adopt the idea of stopping trains with air. A patent was granted in 1869, and a small shop employing one hundred men began the creation of an industry in which tens of thousands are now employed the world over, and in which tens of millions are invested.

The greatness of an invention must be measured by its economic effect. Gaged by that standard the airbrake is one of the greatest contrivances that ever was conceived by man. It made the modern high-speed train possible; it gave a new impulse to railroad transportation. It is not so difficult to devise engines which will haul cars at the rate of sixty, seventy, eighty miles an hour through space. Even on the old Stockton and Darlington road, the first commercial railway ever built, Stephenson's early locomotives sometimes attained a speed of sixty miles an hour. But high speed may not be maintained unless the on-rushing vehicle can be quickly stopped. When his brake appeared the fast train really became possible. In a very real sense, therefore, Westinghouse made it possible to travel in eighteen hours from New York to Chicago.

After the airbrake had been definitely introduced, Westinghouse began to improve it. He was always introducing improvements. Indeed, his personal interest in its perfection did not terminate until about 1901, and even after that he supervised the engineers who adapted the brake to the heavier and faster passenger trains, and the longer freight trains that railways were introducing.

In its development in the hands of Westinghouse himself the airbrake passed through what may be called the "straight-air," "plain-automatic," "quick-action-automatic" and the "high-speed brake" epochs.



The early form of the straight airbrake.

The latest type is known as the electro-pneumatic brake, which will be described and illustrated in an article soon to be published in the SCIENTIFIC AMERICAN. In the evolution of the airbrake, Westinghouse made it a point always to meet existing conditions. Hence, while each one of the types mentioned marked a wonderful advance, not a single airbrake appliance has ever been brought out that would not couple up and work in complete harmony with all prior equipment. Up-to-date airbrake equipment has been furnished for a total of approximately 2,800,000 freight cars, 86,300 passenger cars, and 78,400 locomotives. If this rolling stock were coupled into one solid train, it would encircle the globe on the parallel of Pittsburgh one and one fifth times.

The great changes in braking equipment indicated by these types were necessitated by economic conditions. Very heavy locomotives and heavy passenger cars were necessary to meet the increasing demands of the traveling public, and very long freight trains were required to haul goods long distances cheaply. In the '70s freight cars weighed 10 tons and locomotives 25 tons, with a tractive effort of 7,000 pounds. The average train at that time consisted of not more than 15 or 20 freight cars and four or five passenger cars. In the next epoch freight trains increased to fifty cars—an increase which Westinghouse met by redesigning freight brake equipment. It was thought that the maximum length had been reached; yet to-day freight trains are sometimes 130 cars long. The increased length and the new hazards created were again met by improvements. If these remarkable advances in transportation—made possible in large part by increasing the efficiency and flexibility of the airbrake—do not prove that Westinghouse's greatest invention is more than a mere safety device, we have only to turn to the subway of New York for additional evidence to the contrary.

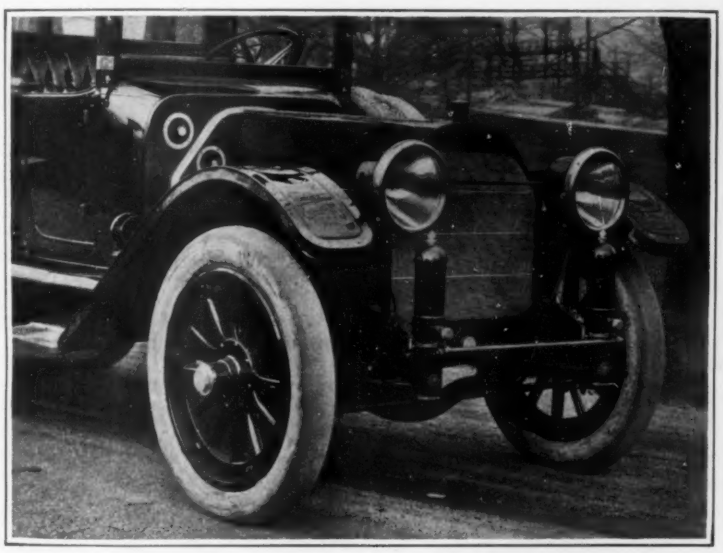
In 1907 the New York subway handled 258,000 passengers per day; in 1908, 704,000 passengers per day. It was obvious that the transportation facilities had to be improved. It was also obvious that the subway itself was a permanent structure, and could not be enlarged. There was just one possibility of meeting the congestion—to lengthen trains from five to seven cars. To accomplish that feat it was necessary to devise an entirely new type of airbrake. When that was done the Interborough cars ran seven-car trains in 1908, and handled an average of one million passengers daily. But by 1911 the traffic had again become so congested that ten-car trains had to be introduced. Again the airbrake equipment had to be improved. This was accomplished by means of the electro-pneumatic brake. At the same time the spacing of the block signals was reduced so as to provide for 90 seconds headway. What the improved airbrake has meant to the Interborough Railway system was thus set forth by a prominent official of the road at a recent meeting of the American Society of Mechanical Engineers:

"The Interborough Rapid Transit Company is now carrying as high as 1,200,000 passengers per day in the subway. To go back to the airbrake equipment used only four years ago would mean that 400,000 of these people would have to walk, as it would be an utter impossibility to operate a sufficient number of trains over the road to carry them."

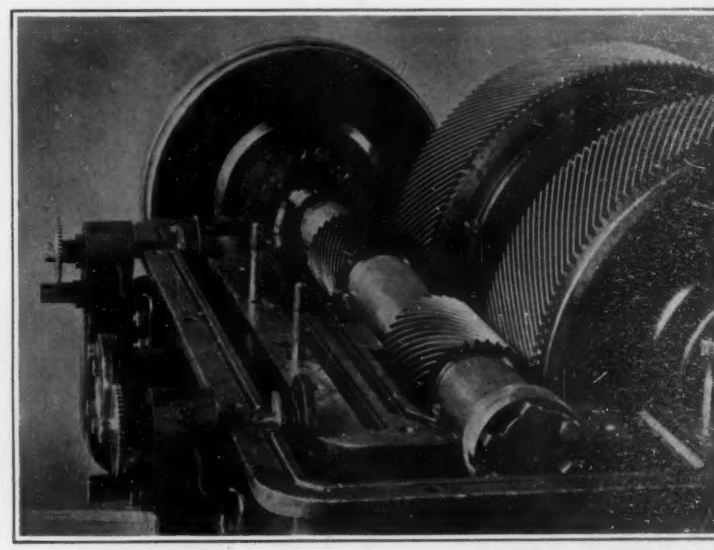
Soon after the airbrake was successfully introduced, Westinghouse turned his attention to railway signals. Only those familiar with the history of railroading know that he was the father of the modern automatic signal. At first he used compressed air to operate the signals, later electricity. Thus the modern electro-pneumatic signal was created.

It is curious that the more important of Westinghouse's railway inventions had for their primary object the saving of human life. But the lives to be saved were not merely those of passengers who trustingly paid their fares and took their plush seats, but also of trainmen themselves. The automatic car coupler, he felt, minimized the danger of connecting cars; but it did not eliminate the danger entirely. Steam and air pipes had also to be connected, and the man whose duty it was to couple them might lose his life if a hasty engineer opened the throttle too soon. So Westinghouse invented, comparatively late in life, a device which would not only couple cars, but also pipes—the whole in a single automatic operation. Perhaps the greatest application of these automatic couplers is to be found on the New York subway—great not in the sense that many cars are utilized by the system, but that more than a million passengers a day are carried, whose lives are in a measure dependent on tight joints. The order for the subway equipment came to Westinghouse when the idea of automatically coupling the pipes of an electric train was more or less in embryo. Yet so

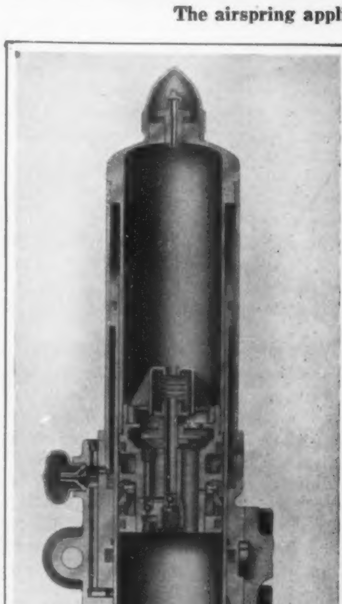
(Continued on page 273.)



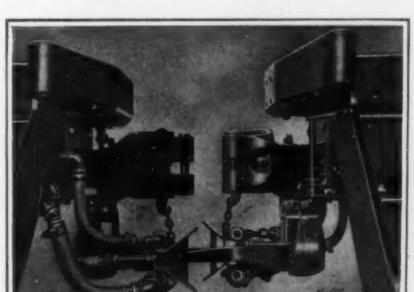
The airspring applied to the automobile.



The Melville-Macalpine-Westinghouse reduction for turbines.

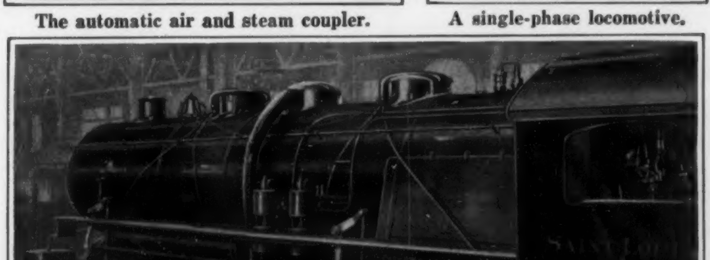


Sectional view of the airspring.

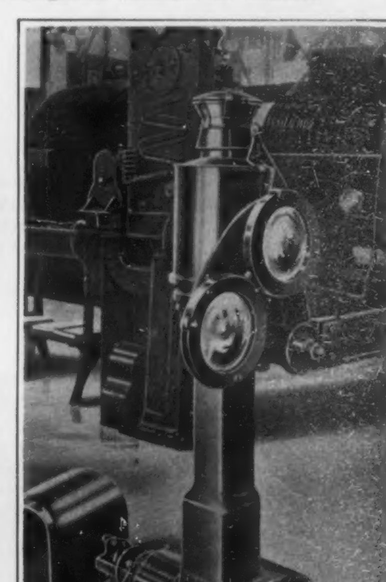


The automatic air and steam coupler.

A single-phase locomotive.



Baltimore and Ohio Railroad's 240-ton articulating compound locomotive equipped with Westinghouse airbrake.



The all-electric interlocking motor-operated signal.

SOME IMPORTANT INVENTIONS WITH WHICH THE NAME OF GEORGE WESTINGHOUSE IS CONNECTED AS INVENTOR OR ENGINEER

The Heavens in April

Discovery That the Sun as a Whole Possesses a Magnetic Field

By Henry Norris Russell, Ph.D.

THERE is probably no one publication which contains in small compass so much new and interesting astronomical material as does the annual report of the director of the great Mount Wilson Observatory. The account of its activities during 1913, which has recently been published, gives in summary form a list of no less than seventy-two results of the year's work, of varying importance, but without exception valuable additions to the sum of astronomical knowledge.

First in the list is a discovery of great importance—made public, with the detailed evidence, some months ago, but not hitherto discussed in these columns—namely, that the Sun as a whole possesses a magnetic field. In other words, the Sun acts like a huge magnet, just as the Earth does. If one could imagine a compass needle to be carried from the Earth's surface to the Sun's, and protected against the destructive effects of temperature, it would point, approximately, at least, toward the Sun's north pole, and the force which caused it so to point would be some fifty times as strong as on the Earth. The detection and confirmation of this magnetic force is a triumph of observational precision and skill. The methods of investigation are similar in nature to those which proved the existence of strong magnetic fields in sun-spots, but the quantities which have to be measured are so small that the greatest care was necessary in their determination.

We may recall that, when a luminous vapor is placed in a magnetic field, and viewed in the direction in which the magnetic force runs, the lines in its spectrum, previously single, appear to be split up into very narrow pairs, whose separation increases in proportion to the strength of the magnetic field. But this timing of single lines into doublets is not the whole story. The two component lines of the pair have certain properties which are not found in ordinary light; their light is "circularly polarized." Without stopping to define the exact physical meaning of this term, we may pass to the practically important fact that it is possible to set up an apparatus composed of mica and Iceland spar (and called a quarter-wave plate and Nicol prism), such that, if it is placed in a certain position, the light of one of the two components of the magnetically doubled line passes through it freely, while that of the other will not get through it at all. By turning part of the apparatus at right angles to its former position, we can reverse the situation, blotting out the line which was formerly visible, and bringing into view the one which had before been extinguished.

Such a change in the arrangement of the apparatus, however, makes no difference in its action upon ordinary light. A double line which did not owe its separation to magnetic action would always appear double, and neither of its components could be blotted out at will.

It was in this way that Prof. Hale showed that the double lines which appear in sun-spots arose from the action of a powerful magnetic field, which is strong enough to separate many lines into pairs which can be easily separated with a powerful spectroscope, though not all the lines, for the same magnetic field influences some lines much more than others.

The last year was one of minimum sun-spot activity, and hence a very favorable time for the study of the Sun's general magnetism, without interference by the powerful effect of the spot disturbances. Theoretically, it may be shown that if the Sun's general magnetic field were strong enough, the lines in the spectrum would be split up into doubles, such as we have just described, when the light came from points about half-way between its equator and its poles; but not if the light came from either pole or from the equator. Though the doubling would occur with light from either the northern or southern hemisphere, it would be found that the two doublets were not alike. Setting up an apparatus such as has been described, and adjusting it so that in the light from some point north of the Sun's equator, the component of the doublet which lay nearest the red end of the spectrum was transmitted, and the violet one extinguished, we should find, on passing light from a point south of the equator into the same apparatus, that the violet component was now transmitted, and the other one blotted out. If the magnetic field under investigation was weak, the pairs of lines would be so little separated that they could not be seen double—they would overlap. But, even so, the edges of the compound line, where one of the components stuck out beyond the overlapping portion of the other, would be circularly polarized, and, by proper manipulation of our apparatus, we might extinguish first one edge and then the other of the compound line, and thus cause a slight shift of its middle toward the unextinguished edge.

This last phenomenon is just what has been found in the Sun. The apparatus was set up in such a way that in a series of parallel strips of spectrum photographed simultaneously on the same plate, the red and violet edges of the line should be alternately extinguished. A line which showed the effect, even to a very small degree, would therefore exhibit something resembling a zig-zag appearance, while unaffected lines would seem straight across all the strips.

Upon making the observations, the majority of the lines showed no effect, but a few not very conspicuous ones gave distinct evidence of a shift—just big enough to measure, but changing from one hemisphere of the Sun to the other, and also with changes in the arrangement of the polarizing apparatus, in exactly the way demanded by theory. The actual amount of the shift is exceedingly small, being, even for the most affected lines, only about 1/4,000th in part of the distance between the familiar pair of yellow lines of sodium; but the numerous and very precise measures of the Mount Wilson observers place its reality beyond doubt. Comparison with laboratory experiments which gave the separation of the two components of the line by powerful magnetic fields, showed that the magnetic forces acting in the Sun were about eighty times as strong as those on the Earth's surface. This is a preliminary value, reduced somewhat by later observations.

Since other lines in the spectrum do not show any such effect, Prof. Hale concludes that the strength of the magnetic force is greatest at the bottom of the solar atmosphere, and diminishes upward. There are various reasons to suppose that the lines which show the effect are produced in the lower part of the atmosphere.

At 11 o'clock: Apr. 7.
At 10½ o'clock: Apr. 14.
At 10 o'clock: Apr. 22.
At 9½ o'clock: April 30.
At 9 o'clock: May 7.
At 8½ o'clock: May 15.
At 8 o'clock: May 22.

NIGHT SKY: APRIL AND MAY

The Heavens.

The winter constellations are now fast vanishing from our skies. At the hour chosen for our map, Orion and Taurus are practically gone, and Auriga, Gemini, and Canis Minor are low in the west. Leo and Virgo are high on the south and southeast, with the mighty length of Hydra below them bearing the smaller figures of the Cup and the Crow upon its back. Scorpio is rising in the southeast, Ophiuchus in the east, and Lyra in the northeast. Hercules, Corona, and Boötes are higher up in the eastern and northeastern sky. The Great Bear is high in the heavens, just north of the zenith. Lower down are the Little Bear and the Dragon, and still lower Cassiopeia and Cepheus close to the horizon.

The Planets.

Mercury is a morning star all through April, but is best seen during the first week of the month when he is farthest from the Sun. His greatest elongation (or apparent distance from the Sun) is 27 degrees 46 minutes, on the 7th; and on this date he rises at 4:45 A. M., and is easily visible in the morning twilight.

Venus is an evening star, still apparently pretty near the Sun, though really far behind him. She sets at about 7:50 P. M., in the middle of the month, and is easily visible shortly after sunset.

Mars is evening star in Gemini, moving eastward into Cancer at the end of the month. He has greatly diminished in brightness, and appears about equal to Pollux, south of which he passes at about 5 degrees distance in the middle of the month. Jupiter is morning star in Capricornus, rising about 3:30 A. M. on the 1st, and 1:40 on the 31st.

Saturn is evening star in Taurus, setting a little after 10:30 P. M., in the middle of the month.

Uranus is in Capricornus, observable only in the morning hours. Neptune is in Gemini, and is in conjunction with Mars on the 21st, being 2 degrees 34 minutes south of him. The distance between the planets is too great to make this conjunction of any use to the amateur in identifying Neptune, for many faint stars, resembling the planet in a small telescope, will be nearer Mars than Neptune is.

Mars is in quadrature, 90 degrees east of the Sun, on the 10th, and Neptune on the 16th.

The Moon.

First quarter comes at 3 P. M. on the 3rd, full Moon at 8 A. M. on the 10th, last quarter at 3 A. M. on the 17th, and new Moon at 6 A. M. on the 25th. The Moon is nearest us on the 10th, and farthest away on the 23rd. As perigee comes very near full Moon, we may expect unusually high spring tides at that time.

As she makes the circuit of her track, the Moon comes into conjunction with Saturn on April 1st, Mars (pretty closely) on the evening of the 3rd, Neptune on the 4th, Uranus and Jupiter on the 18th, Mercury on the 23rd, Venus on the 27th, and Saturn again on the 28th.

Delavan's comet is now out of sight, as we are on the far side of the Sun; but the latest calculations confirm the earlier ones in showing that it is still a long way off, and approaching the Sun, and that it will probably be visible to the naked eye, and perhaps conspicuous, next autumn.

Princeton University Observatory.

Finding Rare Metals by Spectroscope

MINERAL waters are easily analyzed by means of the spectroscope, as shown by M. Jacques Bardet, and this is likely to prove one of the best methods for this work. He sends a beam of light through the water to be analyzed and thence through the spectroscope prism, in order to permit of examining the spectrum, this method revealing very minute traces of metals. He finds the most varied metals in different samples of mineral water, and even the rarest metals, such as germanium and gallium, which are very rarely found in nature.

An Agricultural Car in the Philippines

THE Bureau of Agriculture in the Philippines has adopted the plan, familiar in the United States, of sending a car from place to place over a railway system, specially fitted out for exhibitions, demonstrations and lectures on agricultural subjects. During a month's trip over the Manila Railway stops were made at twenty towns, and, in spite of unfavorable weather the car was visited by over 12,000 people, while more than 5,000 attended the nightly illustrated lectures. Improved seeds and a large amount of agricultural literature were distributed.

How the Kinematograph Facilitates the Study of Tissue

Affording Once Undreamed of Opportunities for Detecting Rapid Embryonic Changes

By Genevieve Grandcourt

IN speaking recently before the British Association at Birmingham, Sir Oliver Lodge expressed the opinion that in the interplay of physical, chemical and mechanical forces, "Life introduces an incalculable element. The vagaries of a fire or a cyclone could all be predicted by Laplace's calculator, given the initial positions, velocities, and the law of acceleration of the molecules; but no mathematician could calculate the orbit of a common housefly. A physicist into whose galvanometer a spider had crept would be liable to get phenomena of a kind quite inexplicable until he discovered the supernatural, i. e., literally superphysical cause."

It is the study of the very beginnings of discernible difference between animate and inanimate, of life from its earliest unfolding under the microscope (for example, of the chicken in the egg) that is the province of modern embryology.

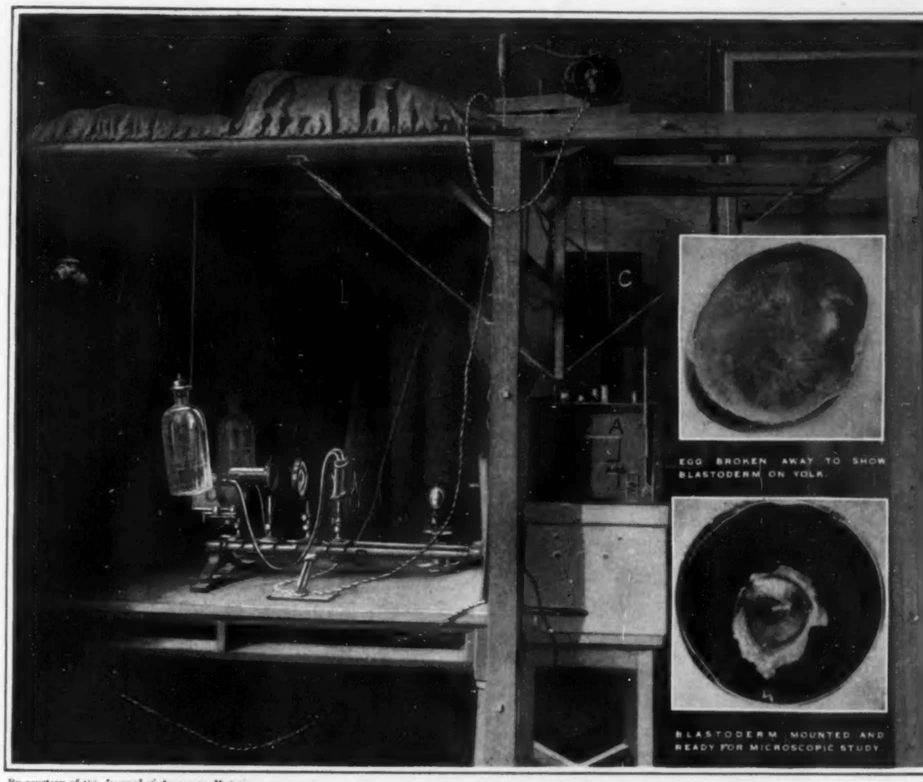
Impossible as the development of this science would have been without the relative perfection of the microscope, two other discoveries of recent time have been enlisted in its service; one, the demonstration by Harrison in 1907 that the nerve-fibers of the frog may be artificially cultivated; the other, the moving picture, which affords once undreamed-of opportunities for the detecting of rapid changes in the evolving embryo—changes which may have a very great bearing upon now obscure problems of the origin of life and in pathology.

For a time, experiments in artificial tissue-growth were confined to extracting small particles of living tissue, and causing the proliferation of its cells *in vitro*, that is, in the same way that colonies of microbes are multiplied for bacteriological purposes. The artificial cultivation of the entire embryo was undertaken more recently by Drs. McWhorter, Whipple and Prime of Columbia University.

The method adopted was to put fresh hen's eggs into a specially prepared incubator heated to a temperature of from 99.5 to 104 deg. Fahr., and keep them there from one to two and a half days; then under aseptic conditions to remove the blastoderm, i. e., that portion of the fertilized reproductive cell (ovum) which develops into the embryo and under appropriate conditions into a living thing.

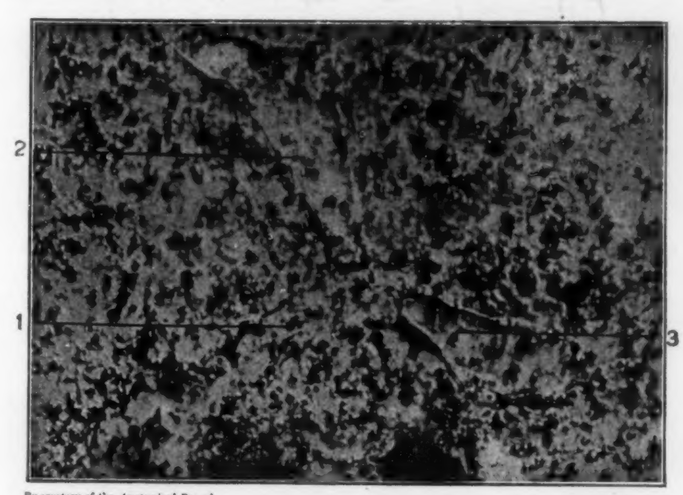
Early experiments showed that there was difficulty in removing the blastoderm from the egg in such a state as to permit of its artificial growth if it was abstracted either before the so-called "head-fold" had had time to appear, or after the egg had been incubated for a longer period than sixty hours. Success, however, has been had with much older embryos.

If the egg had been in the incubator for a day and a half, and the course of its development was regular, the blastoderm was found to lie on the surface of the yolk, as shown in one of the accompanying photographs. It was then separated from the yolk with scissors, and while lying in a salt solution, was freed from any extraneous matter (such as the granules of the yolk, etc.) which might adhere to it. On being transferred to the glass cover of the chamber in which it was subsequently to grow under the heat of the oven, it was drained of the salt solution, and over it were placed a few drops of fowl's blood; this blood having, meantime, undergone preparation as plasma through being deprived of its cells by centrifuging, and then refrigerated. The blastoderm so prepared was left exposed to the air long enough for the blood-plasma to coagulate, and thus hold the specimen firmly to the glass. One of our illustrations shows the blastoderm after the glass cover has been inverted over the glass cell or chamber, and made "ready for microscopic study and photography." The subsequent process of unfolding is analogous to nature's course in the egg.



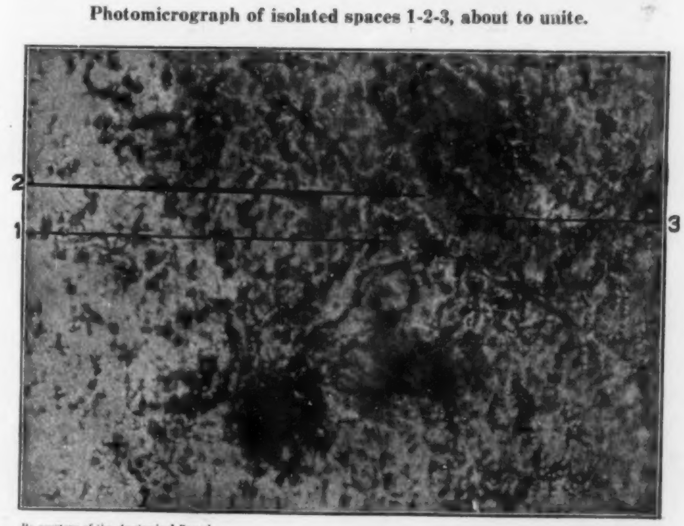
By courtesy of the *Journal of American Medicine.*

Apparatus for kinematographing tissue growth. A, modified incubator; B, optical bench; C, kinematograph.



By courtesy of the *Anatomical Record.*

Photomicrograph of isolated spaces 1-2-3, about to unite.



By courtesy of the *Anatomical Record.*

Same as the picture above with spaces 1-2-3 united.

One of the many unsolved problems in embryology hangs about the origin and unfolding of the middle of the three layers of the primitive embryo (mesoderm), out of which are evolved the connective tissues, blood vessels and lymphatics. Observations have been made of many forms of life with a view to obtaining light upon the subject, the most trustworthy with regard to the lizard and the chicken. It seems pretty well established that the mesoderm unfolds by a uniform process from amphibia to mammals. As soon as it is visible as a distinct layer, two classes of cells are to be discerned in its structure, one of which sets busily to work to form a network of cavities which are the starting-points of the earliest blood vessels.

With the expectation that the artificially developed blastoderm would throw light upon the evolutionary process of the entire vascular system, these cavities or spaces were studied under the microscope and photographed. They appeared of unequal size and shape; sometimes, indeed, merely wandering off into undifferentiated tissue, but often having easily traced boundaries. Under the magnifying glass, these spaces were seen undergoing constant alteration of size and outline, meeting and flowing into each other—forming channels. At a certain point, the change became too rapid to be followed, and suddenly the observer looked to find the spaces had been swallowed up. Cells or groups of cells were moving in the newly formed channels, the walls of which began to dilate, demonstrating that there was pressure of fluid within. When bordering channels met in the form of a net-work, the first heart beat was established.

At this point began an oscillating motion of the cells in the lumen of the channels, and, the circulation being under way, these cells could be seen "breaking off from cell masses," when they "suddenly shot through the channels as if an obstruction were suddenly removed," affording in this way "a remarkable example of the effect of the hydrodynamics of the pumped fluid in these channels."[1]

Observations made from the time of the initial heart beat, and especially on the development of the first two folds of the heart, are essentially technical.

In elaborating the study, the obvious

(*Concluded on page 273.*)

[1] *Anatomical Rec.*, Vol. 6, No. 3, Mch., 1912.

A motor-propelled fire engine racing through the snow.

The Motor-driven Commercial Vehicle

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The Editor will endeavor to answer any questions relating to mechanical features, operation and management of commercial motor vehicles.

Engine fitted with front drive, virtually a two-wheeled tractor.

Modern Motor Fire Apparatus

By Ross Babcock

A LITTLE more than three years ago motor-propelled fire apparatus was a genuine curiosity. At the end of the year just closed we had 8 important cities without a single piece of horse-drawn apparatus; all motors. Others rapidly are following their lead as is evidenced by the fact that there are now more than 820 cities that have installed gasoline fire fighting apparatus; their total equipment includes more than 2,100 separate pieces. And the investment represents, in round figures, more than $10,500,000! The amount has almost quadrupled in as short a time as 18 months.

Nor are the big cities the only ones that have seen the light and turned their horses out to green pastures. Some of the little ones are just as progressive. Take the cities of Springfield, Mass., and Macon, Ga., for instance. Springfield is about sixtieth in the country in point of size, but it ranks third in the proportion of motor-propelled fire apparatus. Springfield's population is approximately 89,000, yet it has no less than 32 pieces of motor-propelled fire apparatus. Macon's inhabitants number about 40,665—Macon has 11 gasoline fire wagons.

According to the latest available figures, there are only 6 States that have more than 100 pieces of motor fire apparatus each. Of these 6, New York leads with 253 pieces of apparatus distributed among 66 cities and towns; the others in the proper order are as follows: Massachusetts, 227 machines in 83 cities; Pennsylvania, 155 machines in 78 cities; California, 149 machines in 53 cities; Ohio, 146 machines in 44 cities; New Jersey, 145 machines in 55 cities.

Economy of operation is one of the principal advantages of the gasoline fire engine; the first cost is practically the last cost, barring accidents, of course, and running expenses which in any case are purely nominal alongside the running expenses of horse-drawn equipment. Take the case of the city of Springfield for instance. The Fire Commissioners have prepared a chart which shows (from experience and not in theory) that the average cost of maintenance of 7 pieces of motor-propelled apparatus used as a basis for comparison was $161.89 for a whole year, during which time the average number of alarms responded to by each piece was 140. The cost of horse-drawn vehicles, on the other hand, was $524.18, and the average number of alarms was but 125. The figures speak for themselves.

Chief W. H. Jones of the Richmond, Va., Fire Department, said in a recent paper: ". . . Its upkeep (referring to a triple combination chemical, pumping engine and hosecart) has been only about 6 per cent of the cost of the horse-drawn, while its efficiency has been 60 per cent greater and it covers double the territory formerly assigned to the horse-drawn apparatus of this particular company."

Here is a conservative estimate of cost made by a reputable manufacturer:

HORSE-DRAWN STEAM FIRE ENGINE.

Feed for four horses	$600
Shoeing horses	72
Veterinary and medicine	80
Blankets, brushes, etc	80
Driver for hose wagon, also stoker and engineer for steamer	2,700
Coal for steamer	75
Harness repairs	40
	$3,647

MOTOR-DRIVEN PUMPING AND HOSE CART.

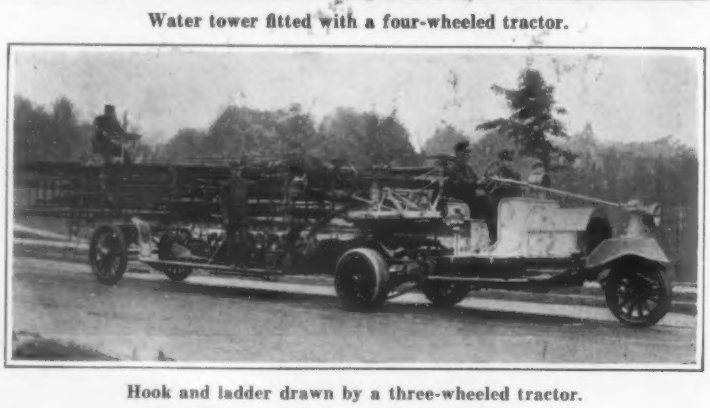
Tire expense	$120
Gasoline and oil	45
Battery charging	3
	$168

Annual saving of motor apparatus, $3,479.

These figures do not include the cost of building maintenance, which, with motor apparatus, must be less than with horse-drawn, for less room is required for the former.

Fire engine in which both the propulsion and the pumping are done by a six-cylinder motor.

Water tower fitted with a four-wheeled tractor.



Hook and ladder drawn by a three-wheeled tractor.

Let us examine the records that have been made by some of the more modern fire apparatus and in this way bring to light another and very important advantage. For instance, these figures come from the Fire Department of the city of Colorado Springs: Loss in 1911, when it had no motors, $27,000; loss in 1912, with three pieces of motor apparatus, $8,000. Any number of cities report that since the installation of motor fire apparatus, fire losses have dropped off, in several cases by as much as 75 per cent, and in the majority by at least 50 per cent. The city of Pontiac, Mich., estimates that the saving in fire losses in one year paid for its motor equipment. And what is more significant, fire insurance companies look with favor upon such apparatus, and in a noteworthy number of instances material savings in premiums have been effected by property holders.

Motor-propelled fire apparatus itself can be divided into six classes, and in this respect it is pertinent to add that the building of such vehicles requires experience and a square look at the fact that the fire apparatus builder's problems are not those of the ordinary commercial vehicle builder any more than they are those of the pleasure car builder. The successful motor fire wagon must be essentially more or less of a cross between the two. For with the heavy fire engine we have the weight of the commercial vehicle requiring heavy and substantial construction combined with a fair portion of the speed of the pleasure car. Motor trucks seldom exceed 16 or 18 miles an hour, whereas fire vehicles attain speeds anywhere between 35 and 60 miles an hour. Hence their design suggests a number of delicate problems which can only be solved after exhaustive study and experiment.

The six classes of motor fire apparatus include briefly the chief's light runabout, which may or may not carry auxiliary apparatus; the chemical wagon; the ladder truck; the hose wagon; and the pumping engine. The latter may be subdivided to include converted steamers, which are steam pumping engines with gasoline tractive machinery, and gasoline pumping engines which also are driven by gasoline engines. Another division includes combined pumping and chemical engines which also, perforce, carry a quantity of hose.

The chemical engine may range in size from an almost miniature machine with a single small tank to a mammoth six-cylinder machine capable of fighting a really stubborn blaze—and extinguishing it.

Due to the disinclination of municipalities to scrap steam pumping engines which still are useful, quite a number of makers have evolved chassis upon which these pumps can be mounted and so serve out the remainder of their useful lives. In some designs the steam apparatus is mounted bodily upon a special chassis; in another the forward wheels of the en-

(Concluded on page 272.)

RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Of Interest to Farmers.

MANURE SPREADER.—J. A. OLSON, Hildreth, Neb. The invention refers more particularly to the class comprising a pair of spreaders the distance between which is automatically varied by the material passing between the spreaders. It provides a spreader in which the pressure produced on the spreaders by the material passing between them is automatically adjusted.

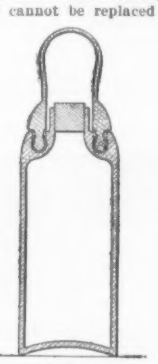
SWEEP STOCK PLOW.—H. T. YOUNG, Florence, S. C. This invention is for use for siding young corn and for the cultivation of cotton throughout its growth, wherein mechanism is provided for permitting the plow to be used toward and from the beam without dismantling the plow or removing the plow from the supporting hanger, and wherein the plow may be held in adjusted position firmly and without any attention from the operator, wherein the stock is supported from the beam, so that it may swing with the plow, and wherein the stock is connected to the plow to swing in unison therewith and to hold the same relative position with respect to the plow regardless of the position of the plow.

PRESS.—L. MATTHEWS, Paris, Tenn. This invention is adapted for use in baling hay and like articles, wherein a pressing chamber is provided, and a plunger movable longitudinally of said chamber and having means of engaging the chamber for guiding the plunger, together with power operated mechanism for reciprocating the plunger.

Of General Interest.

RIBBON DEVICE.—W. F. SPRICK, Stickney, S. D. This device is adapted to support and display a roll of ribbon or the like attractively and to so hold the ribbon that any desired amount may be readily unwound and removed without displacing the roll or rumpling or soiling the ribbon, and wherein means is provided for permitting ribbons of different widths to be handled.

BOTTLE.—C. V. JOHNSON, Goldfield, Nev. This bottle cannot be opened after being sealed by a cover, without first breaking the cover, and the cover cannot be replaced without de-



BOTTLE.

tection. The cap or cover is designed to be fitted over the ordinary neck of a bottle, and there is the necessary maximum amount of space within the cover and exterior of the bottle neck, for containing data concerning the filling of the bottle, or of other information concerning the goods therein.

MEANS FOR CLEANING SEWERS.—J. BRUCE, 3258 Thayer St., Pittsburgh, Pa. A small opening is cut in the sewer and the device is introduced through such opening and then rotated by means of a hand brace or other equivalent. The device is constructed of steel wire, preferably in the form of a loop, and the free ends of the strands of wire are secured in a suitable clamp which is, in turn, attached to a hand-brace.

COMBINED ASH CAN AND LAWN ROLLER.—J. C. B. JARVIS, 1514 76th St., Brooklyn, N. Y. This invention provides a can having a cover and provided with a sleeve supported by the bottom of the can and the cover for receiving an axle so that when the arms and the tongue are pivotally connected with the axle, the can may also be filled with ashes, and used as a roller for rolling the lawn, tennis courts, etc.

Hardware and Tools.

CAN OPENER.—L. E. HOLMES, Robbinston, Maine. This improvement relates to tools or implements for opening tin cans of fruit, vegetables or the like. Among the objects is to produce a tool of a simple and comparatively cheap construction which is not only easy and reliable of operation, but also which is not likely to damage the contents of the can or receptacle being acted upon.

DRILL BIT.—A. W. TAYLOR, 312 Rose St., Peckville, Pa. The design of this invention is to provide a drill that will readily cut through hard substances, and a drill that may be turned easily in the drill hole, and that will produce a straight smooth hole to properly receive the cartridge. The invention provides a plural bit, the elements of which may be readily removed and renewed.

SAFETY RAZOR.—L. KALINA, 132 Nassau St., New York, N. Y. The invention provides a safety razor to permit of conveniently assembling the parts for shaving purposes or disassembling the same for cleaning the parts and removal of the blade for stropping or other purposes, the razor being of such shape that when not in use for shaving purposes it can be readily used as a cuff button.

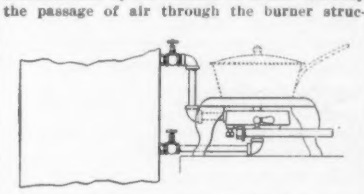
SAFETY RAZOR.—S. KITZES, 630 Concord Ave., New York, N. Y. The object of the invention is the provision of a new and improved safety razor of the flexible blade type, arranged to permit of conveniently and quickly assembling and disassembling the parts, and to

SAFETY RAZOR.

provide a detachable gathering receptacle for the lather. The razor is composed of comparatively few parts, and when in use the lather readily passes into a receptacle which thus forms a shield for the hand holding the razor.

Heating and Lighting.

GAS BURNER AND WATER HEATER.—J. A. FRISK, 702 W. Illinois St., Urbana, Ill. This gas burner is adapted to act as a water heater, the structure shown herewith being characterized by an absence of means whereby the passage of air through the burner struc-



GAS BURNER AND WATER HEATER.

ture is prevented. The invention provides a burner and heater, preferably of integral construction, the embodiment shown making provision for the utilization of heat below the burner openings as well as along the sides thereof.

Household Utilities.

WINDOW CLEANING PLATFORM.—H. BOTTJER, 631 Classon Ave., Brooklyn, N. Y. The invention relates to temporary platforms or scaffolds, and has particular reference to means for supporting an operator and cleansing materials in the cleaning of windows. He

WINDOW CLEANING PLATFORM.

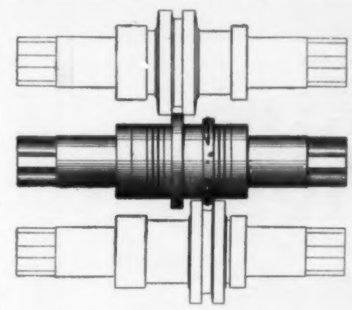
also provides a platform of the character indicated, which may be adjusted to fit any ordinary size of window, and which will be strong and reliable when used in any position of adjustment with respect to the size of the window.

EXTENSION TABLE.—V. F. NEUMANN, Tivoli on Hudson, N. Y. This invention embodies a plurality of sections or leaves which, when not in use, can be pushed in or out of the way under the table top. An equal number of leaves are used at opposite ends of the table so that it can be lengthened at one or both ends, as desired. When the length of the table top is increased by the extensions, one or more of said extensions can be employed, so that the top of the table can be lengthened at either or both ends to a greater or less degree.

CONVERTIBLE SOFA AND BED.—J. F. KAMPE, 246 67th St., Brooklyn, N. Y. The invention relates to furniture, and its object is to provide a new convertible bed and sofa, which is simple and durable in construction and arranged to permit of conveniently changing the sofa to a bed or *vice versa*. Comparatively few parts are required for accomplishing the desired movement of the back when folding the same to form the back for the sofa or when extending the same to form an outer section of the bed.

Machines and Mechanical Devices.

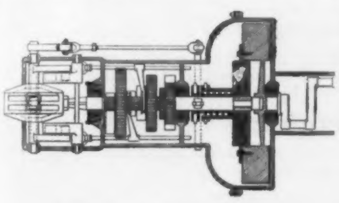
SHAPING ROLLS FOR HORSESHOE BARS.—L. T. PAGE, Box 104, Wareham, Mass. This invention provides means for mechanically creasing and partially punching the bars from which horseshoes are subsequently made; prevents the creeping or misregistering of the rolls



SHAPING ROLLS FOR HORSESHOE BARS.

with the bars and shoe-forming sections thereof; reduces the friction offered by the bars to the rolls when passing therethrough; and provides rolls of the character mentioned, having a simplified and economical construction.

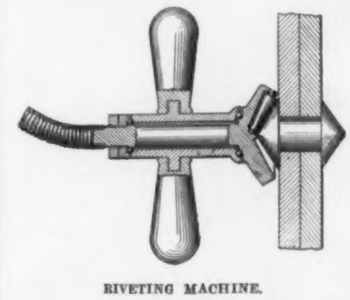
TRANSMISSION MECHANISM.—A. B. BROCKMAN and W. BROCKMAN, Lawrence, Neb. This invention provides a mechanism of the finest possible parts, and of the simplest type, wherein a selective lever is provided for controlling both the clutch and the gear trans-



TRANSMISSION MECHANISM.

mission mechanism, and wherein when the selective lever is in neutral position, the gear transmission mechanism is out of mesh, and when moved out of neutral position the selected gear is first fully engaged before the clutch is permitted to close, and wherein the gears are always positively locked with respect to the operating lever, which will be reliable, durable and easily operated.

RIVETING MACHINE.—C. SNODGRASS, care of Fritz Kiehn, 940 South Broadway, Los Angeles, Cal. This invention relates to improvements in riveting machines, and has for an object the provision of an improved structure which will evenly rivet or upset the end of a



RIVETING MACHINE.

bolt, rivet, or other similar article with a minimum amount of noise. Another object is to provide a rapidly rotating riveting head formed with rotating rollers acting as the contact members for performing the upsetting operation.

EXHIBITING APPARATUS.—A. P. ROESENER, care of Automatic Electric Sign Co., 814 Macdonough St., Brooklyn, N. Y. This apparatus is primarily designed for advertising purposes; and it comprises a construction which is automatically actuated and controlled so as to move a plurality of slides or negatives in succession into operative relation with respect to a projecting device by means of which the designs formed on the slides are thrown upon a screen, to be viewed.

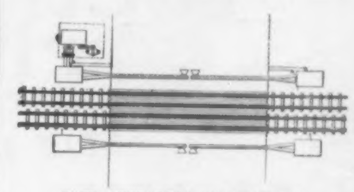
APPARATUS FOR DRYING ARTICLES FORMED FROM PLASTIC MASSES.—O. EBERHARD, Heidenau, near Dresden, Germany. The drying of objects formed from plastic masses, particularly those containing a large proportion of water, is attended with difficulty because if the drying is not uniform strains may readily arise in the material and produce modification of form. By means of the novel drying device used in the present invention defects and difficulties are eliminated owing to the fact that during the drying operation the material under treatment is given a uniform displacement which produces a constant modification in the positions of several parts of the surface of the object relatively to the source of heat and thereby causes this source of heat to act uniformly on all sides.

Prime Movers and Their Accessories.

INTERNAL COMBUSTION ROTARY ENGINE.—C. L. RAGOT, 903 Clinton St., Hoboken, N. J. The improvement refers to internal combustion rotary engines admitting of general use, and more particularly to a type of such engine which, because of its lightness, strength, smooth running, reliability, simplicity and various other qualities, enable it to be used in connection with flying machines.

Railways and Their Accessories.

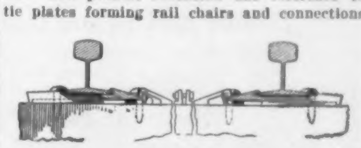
GATE OPERATING MECHANISM.—J. E. C. JACOBSEN, 29 Fourth Ave., Nyack, N. Y., and C. A. V. J. SEGERSTEN, Nyack, N. Y. This in-



GATE OPERATING MECHANISM.

vention comprehends mechanism whereby a train in approaching a predetermined part of a track provided with gates will cause the gate to close automatically, will actuate lamps serving as alarms, and will retain the gates closed and the alarm active so long as the train is present, but when the train departs, the gates are automatically opened and the alarm rendered inactive.

TIE PLATE.—W. M. GLOTFELTY, Ohiopyle, Pa. The present invention has reference to tie plates forming rail chairs and connections



TIE PLATE.

between track rails, the inventor's object being to provide a tie plate particularly adapted for use with certain connections to prevent the rail from spreading, and also constructed so as to receive and retain a tie preservative and prevent the rails from tilting or moving apart.

Pertaining to Recreation.

ARTIFICIAL BAIT.—C. W. STEWART, 120 N. 3rd St., Olean, N. Y. This improved bait is provided with a covering having succeeding layers, each simulating a different fish either as to form or color or both, and the layers are adapted to be successively removed to expose different representations in succession until the correct bait is found to successfully attract the fish under the particular conditions, as season and weather or the particular character of the fish being sought.

Designs.

DESIGN FOR A SET OF CHARACTER-BLOCKS.—DE W. C. BAKER, care of Baker & Bennett Co., 643 Broadway, New York, N. Y. This design is a view in elevation of a set of character blocks representing the complete alphabet and numerals in perspective. The mechanical construction of the blocks is so perfect in design that it gives a surprising ornamental effect in each character.

DESIGN FOR A SOIL-PIPE FITTING.—D. HELLER, Baltimore, Md. In this ornamental design for a soil-pipe fitting the article is shown both in a side view and a longitudinal section view.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Modern Motor Fire Apparatus

(Concluded from page 270.)

gine are replaced by a three-wheeled tractor, and in still another the forward wheels have been replaced by what virtually amounts to a two-wheeled tractor, the engine standing well out in front and driving through a shaft and side chains.

The vehicle which utilizes but one engine for propulsion and pumping is being widely adopted because of its efficiency and the absence of necessity for carrying two kinds of fuel. All of these machines will run at great speed to a fire, after which a simple clutch serves to disengage the motor from the propelling machinery and engage it with the pump; there is no need to wait for steam and no lack of water pressure because of low steam; incidentally, the unit is generally self-contained in that it carries its own hose; it is independent of the hose wagon which may never reach the scene of the fire because of some accident.

The motorizing of ladder vehicles suggests other problems because of the great length of the equipment. Tractors have been pushed into the breach, so to speak, and have made easy the solution of a problem that might have proved troublesome. At the same time their use permits existing apparatus to be kept in service, for in the majority of cases it is a simple matter to remove the front wheels and substitute the tractor. One of our illustrations shows a water tower with a four-wheeled tractor.

It has been a hard fight to have motor fire apparatus adopted and the antiquated horse-drawn apparatus relegated to the background. But it has been a winning fight from the beginning.

Motor Truck in Snowbound Streets —A Correction

In an article on "The Motor Truck in Snowbound Streets," published in the Scientific American of February 28th last, the following statement was made concerning a motor coal truck:

"Altogether during the three days of the storm it ran about 5,000 miles and used up over 60 feet of tire chains. . . ." It is hardly necessary for us to say that the statement is incorrect. It should have read: "The truck was a stock machine that had run altogether about 5,000 miles. During the three days of the storm it used up over 60 feet of tire chains," etc.

Lifeboat Test Off Sandy Hook

(Concluded from page 262.)

was damaged in collision with an Atlantic liner in New York harbor. The colliding ship evidently crowded the lifeboat against a hatch, and produced the long straight indentation shown in the photograph. This boat was put overboard and towed over a long distance to a yard for repairs, and yet showed no leaks whatever. In spite of this deep indentation the boat would have carried its passengers in an emergency. In tests carried out on the United States Army transport "Kilpatrick," a Lundin steel boat, when half lowered, was pulled away from the ship and allowed to swing back heavily against her hull, with no resulting damage to the boat.

At the conclusion of the tests the three boats were towed from a point several miles outside of Sandy Hook to the Battery at a speed of 13 knots. The first part of the trip was made through rough water, and in spite of this rather brutal treatment, the high rounded bows of the boats carried them comfortably over the seas, and everything was sound and tight when the Battery was reached. The violence of the test is shown in our photograph, taken from the deck of the third ship.

In designing the power lifeboat the broad principle was laid down that all lifeboats, whether with or without power, should always be of such size and construction that they can readily be launched fully loaded, and pushed off the side of the ship as soon as possible after being water-borne. With this in view, the power boat is built with a tunnel by which the propeller and shaft are protected

against any damage while the boat is being launched; and the strength afforded by the double bottom is such that the boat can be lowered when loaded to its maximum capacity of seventy-five people.

How the Kinematograph Facilitates the Study of Tissue

(Concluded from page 269.)

difficulty was the impossibility of following the entire process of the blood-circulation in a single specimen of the artificially developed blastoderm. And it was as a means of getting around this very great obstacle to thorough observation that the kinematograph was employed.

The moving picture catches and reproduces alike the exceedingly slow movements of early tissue growth and cell division, and the subsequent rapid changes connected with the heart and blood vessels, neither of which can be followed satisfactorily in detail through the microscope or by the use of ordinary photography.

By the use of the kinematograph, it is possible also to study the primary divisions of the brain, and various other questions—such, for example, as the reason for the invariable position of the heart on the left side of the body; the significance of which knowledge is apparent only to the embryologist.

The device first used in photomicrography, i. e., a camera fastened to a slotted plate braced by an iron framework screwed to the floor (the camera being connected with the microscope) was but slightly modified on the adaptation of the kinematograph to it. "First, a replacement of the lens by a metal tube; second, the substitution of a pulley and interlocking gearwheels for the ordinary hand-cranking device. The gear wheels, two in number, are of different sizes. The larger is screwed fast to the shafting that operates the mechanism within the camera, while the smaller, to which is riveted a small pulley, engages the larger wheel at one side. This reducing gear is so arranged that one revolution of the pulley gives one revolution of the rotary shutter within the camera, the equivalent of one picture."[3]

George Westinghouse

(Concluded from page 267.)

sure was he of himself that he undertook to design the couplers, although there was no time for elaborate tests. The invention was a success from the very first in actual practice.

Fully as important from an economical standpoint as the invention of the airbrake is the introduction of the alternating current, with which Westinghouse's name must also be conspicuously associated as a promoter and engineer. He heard of the experiments made in Europe with alternating currents; his broad mind immediately saw the possibilities of high tensions; forthwith he began experiments in this country. That so much progress has been made in this country in high tension transmission is due almost entirely to Westinghouse's initiative. Cities situated within two or three hundred miles of a hydro-electric power plant might not be electrically lighted now had it not been for Westinghouse's farsight.

The introduction of the alternating current was marked by a bitter struggle. Influential as he was, heralded the world over as a great inventor and a great engineer, he found it just as hard to overcome opposition to the alternating current as to induce timid railway officials to adopt the airbrake.

There was more than mere ignorance behind the opposition. Vested interests had to be fought—interests which seem actually to have conspired to prevent the employment of a system which has proved itself of world-wide benefit. For fifteen year the attack continued. Even Edison thought it unwise to encourage the use of the alternating current.

The struggle came to a crisis during the

[3] *Journal* of the Am. Med. Assn., Aug. 9th, 1913.

World's Fair of 1893 at Chicago. Westinghouse contracted to light the Fair at a price one million dollars less than the nearest bidder. His opponents induced the exposition authorities to exact a bond for the fulfillment of his obligations, believing that no one would become surety for a bond which might be forfeited because it guaranteed the performance of something which had not been attempted in electrical engineering up to that time. Westinghouse promptly furnished three bonds. Next the patent laws were invoked to deter him. He was accused of infringing existing patents which covered methods of making incandescent lamps. He merely sat down and invented processes and devices of his own which were obviously not infringements. The Chicago Fair made money; but it made it thanks to Westinghouse. The stockholders divided one million dollars among themselves—the exact amount saved by the adoption of the Westinghouse alternating current system.

After the success at Chicago, Westinghouse boldly set to work at designing the giant alternators of Niagara. There are ten of them. To this day they are regarded as monuments in contemporary electrical engineering. In 1912, by the irony of fate, the Edison gold medal was awarded to him at a banquet of the American Institute of Electrical Engineers for his "meritorious achievement in connection with the development of the alternating current system for light and power." Among those who witnessed that event were engineers who had decried the alternating current as a force that could not be controlled, as a form of energy that should not be used because it might kill.

Two inventions, in the development of which Westinghouse played a prominent part, are the Melville-Macalpine-Westinghouse geared turbine for steamships and the automobile airspring. Both inventions have been so fully described in these columns that it is hardly necessary to comment upon them at length again. Interesting, too, is a way of his for controlling the operations of a ship's engines by a device placed on the navigating bridge of the vessel. The movement of a lever on the bridge starts or stops the engines, reverses them, and regulates the speed. By its use the engines of the United States steamship "Neptune," a collier, have been reversed from full speed ahead to full speed astern in twelve seconds.

Breadth of vision and receptivity were characteristics of Westinghouse. Most inventors can see good only in their own creations. Despite all their sufferings and trials they do not often extend a helping hand to fellow inventors. Westinghouse was an inventor of a totally different stamp. Not only was he a great inventor himself, but he did more than any other inventor of his time to develop the inventions of others. He grasped a new idea with flash-like rapidity. Tesla, Nernst, Cooper-Hewitt, Stillwell, Lamme, and a dozen other less important succeeded very largely because of the interest that he took in their labors. He spent fortunes in research designed to aid them.

Westinghouse was essentially what the world calls a practical man. He could work with his hands as well as with his head. He had learned the use of tools in his boyhood; in his youth he had familiarized himself with every resource of the machine shop; and during the years of his manhood he worked on in the same way as if his livelihood depended on the manual exercise of his mechanical skill. Hence he was a type of employer that men must respect; they felt that he could handle their machines as well as they themselves.

It is practically impossible to present a complete view of his economic importance. Perhaps some idea of the vastness of the industries which he created may be gleaned when it is said that there are now thirty-five Westinghouse companies in Europe and America, that they employ 50,000 persons, and that they operate with a total capital of $200,000,000. He himself took out patents on about three hundred inventions, but he controlled as many as 15,000 patents.